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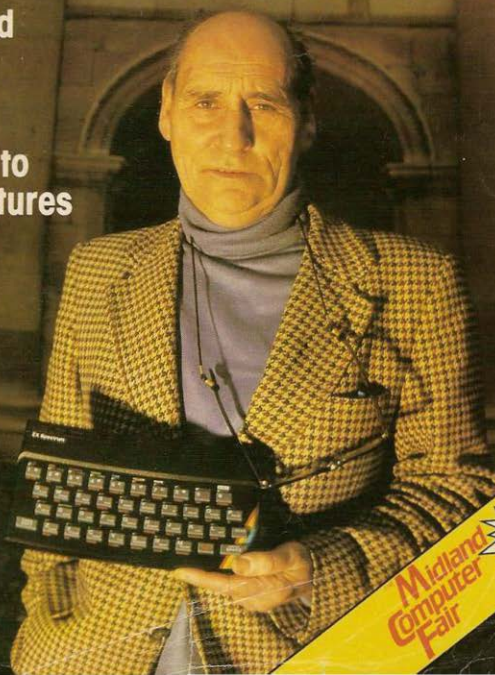

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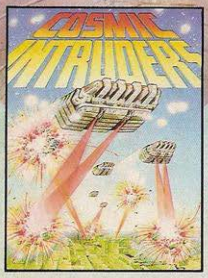

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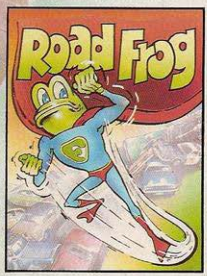

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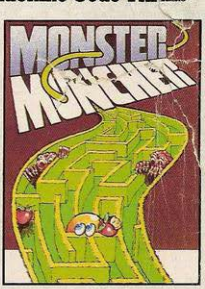

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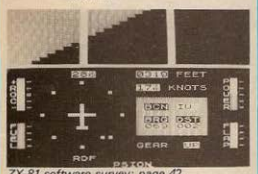
Ghost hunting: page 50.



ZX-81 software survey: page 42.

First Byters get even younger: page 38.

Sub hunt: page 78.

Cover photograph by Stephen Oliver.

28 **EDITORIAL AND YOUR LETTERS:** Spectrum colour for every TV; the good old days; and the break-in controversy continues. How much should your micro cost?

30 **NEWS:** The millionth home computer; ZX-81 high-resolution on cassette; Dragon discs; BBC stringyfloppy microdrives; Sinclairs with 1 Megabyte RAM; and the 80K micro.

35 **COMPUTER CLUB:** Birmingham's computniks are not afraid to use local radio to spread the message as Simon Beesley found at the West Midlands Computer Group.

38 **FIRST BYTES:** Your introduction to computing this month explains what memory mapping means and again helps you to beat those bugs.

42 **ZX-81 SOFTWARE SURVEY:** Peter Connor survives attacks by psychotic alphabets, hostile monsters and King Kong to bring you up to date with ZX-81 software.

48 **TEXAS CC-40 COMPACT COMPUTER:** First of a new wave of micros from the Lone Star state. Ian Stobie weighs up TI's powerful portable.

50 **CHASING SPECTRES WITH A SPECTRUM:** How today's ghost-hunters shadow shadows with electronics.

54 **SPECTRUM ASSEMBLERS AND MONITORS:** Phil Holliday reviews the tools which could turn you into a machine-code programmer.

58 **DRAGON TANKS:** Drive into action with the latest tracked titans. All the options are open from forcefields to minefields in Vince Crockett's two-player game.

62 **VIC FROGGER:** Will the truckers mow you down before you can cross the freeway in Desmond Phillips fast game for the unexpanded Vic-20.

65 **ZX-81 TAPE VERIFY:** Andy Scott presents the Spectrum feature that every ZX-81 owner wants — a verify command when you save to help ensure painless loading.

70 **SPECTRUM SATURN LANDER:** You and your 16K machine are on the first manned mission to Jupiter. Garry Owen gives you a fighting chance of getting there.

78 **ZX-81 SUB HUNT:** Dive, dive, dive is the only chance of survival for the U-Boats lurking beneath the surface which you try to destroy in Rod Hopkins exciting 1K game.

81 **BBC BREAKTHROUGH:** The fun way to explore the BBC operating system with Chris Melville's Breakthrough game as your guide.

87 **ACES CAN GO FASTER:** All the tools you could need to put those go-faster stripes on your Jupiter Cantab are included in Simon Cross's screen kit.

91 **BBC HOUSE OF CARDS:** Learn structured programming with Woodward and Berry's brain-teasing Pelmanism program.

102 **SPECTRUM INTERRUPTS:** Nigel Dore's interrupt-driven routines show you how to create a digital clock and generate sounds and moving landscapes at your whim.

107 **VOICES OF THE VIC:** What have Richard Clayderman and Acker Bilk got in common? That's right — neither of them sound like your Vic-20.

115 **ATARI FINE SCROLLING:** If you were as elegant and sophisticated as Chris Lam you would already have developed these fine scrolling techniques.

119 **DRAGON MONITOR AND DISASSEMBLER:** Brian Cadge's fast machine code routines are just what the doctor ordered for you to diagnose programming errors.

131 **6502 MACHINE CODE MADE EASY:** Get to grips with the language that 6502-based machines like the Vic, Atom, BBC Micro and Oric use.

135 **SPECTRUM VARIABLES:** High speed routines by Stuart Nicholls.

151 **BASIC DICTIONARY:** Tony Edwards completes his marathon.

152 **HISTORY OF SOFTWARE:** John Dawson's Tower of Babel.

159 **RESPONSE FRAME:** Tim Hartnell answers your queries.

161 **SOFTWARE FILE:** 10 program packed pages full of games, tips and serious applications for the Oric, Atom, ZX-81, BBC, Vic-20, Dragon and Spectrum.

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183 **COMPETITION CORNER:** New teaser, Camputers Lynx winner.

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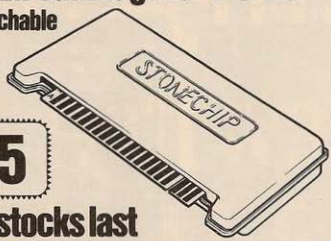

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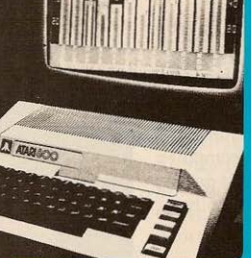

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YC0583 – Your Computer – May 1983

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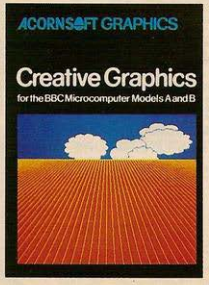
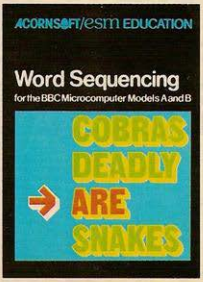
Creative Graphics, which includes the book 'Creative Graphics on the BBC Microcomputer' (price £17.45), provides 36 programs on cassette producing a spectacular range of pictures and patterns in full colour, including animated pictures, recursively-defined curves and three dimensional shapes.

Word Sequencing (price £11.90) contains three word sequencing programs on cassette. Each program presents a series of jumbled words which must be arranged on screen to form either a proverb, nursery rhyme title or a sensible sentence.





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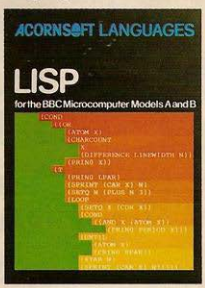
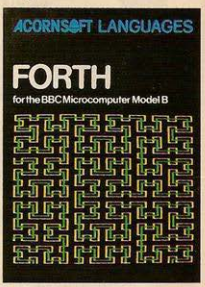
LISP (price £24.35) is the fundamental language of artificial intelligence research.





It consists of 5.5K of machine code interpreter, plus 3K of initialised LISP work-space containing utilities and constants. It comes complete with a book that introduces you to programming in LISP, as well as some fascinating applications.

FORTH (price £24.35) is a complete implementation of the FORTH language to the 1979 standard specification for the BBC Microcomputer Model B. This much acclaimed programming language is also accompanied by a specially written book explaining all you need to know.

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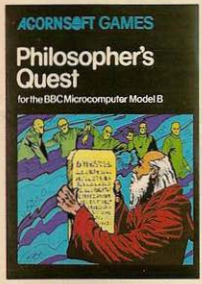

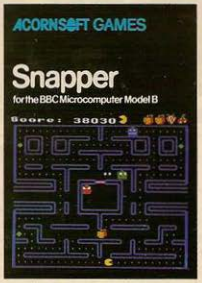

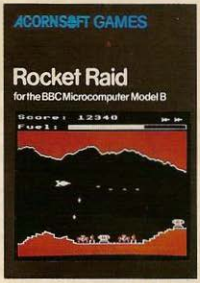

describes back in plain English your progress through a fascinating world of fiendish puzzles to be solved.

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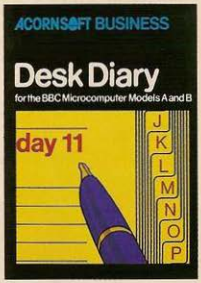

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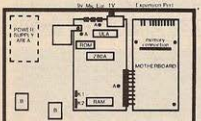

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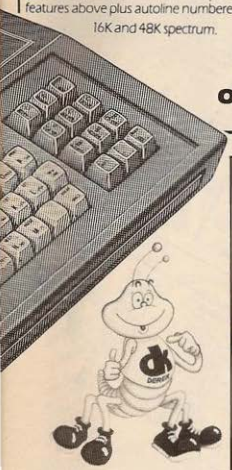

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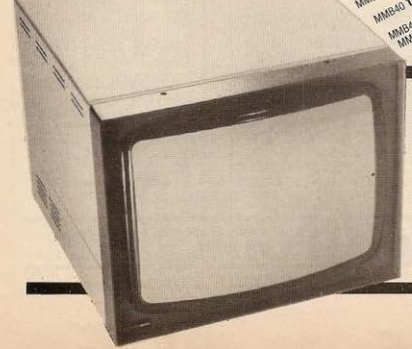

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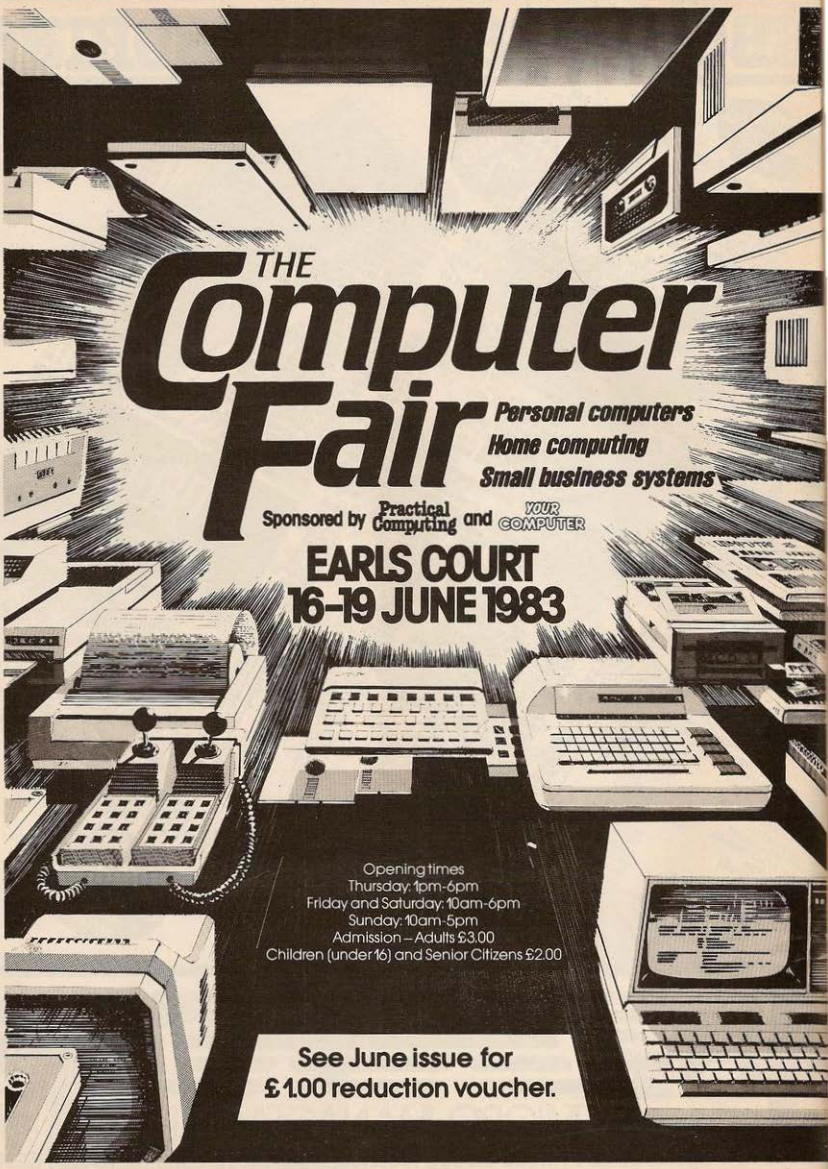
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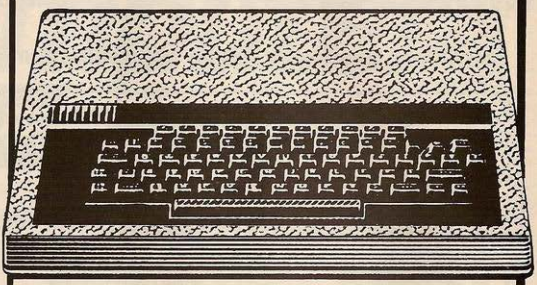

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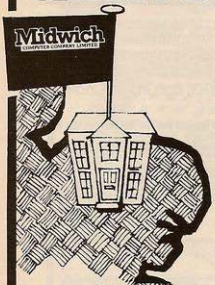

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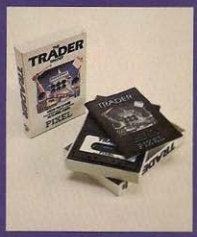

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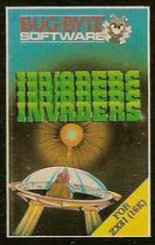

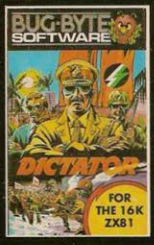

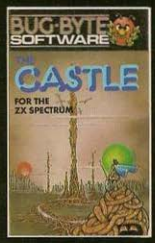

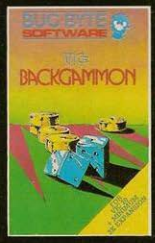

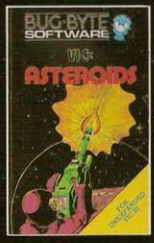

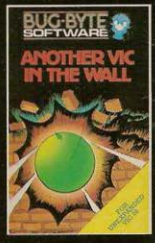

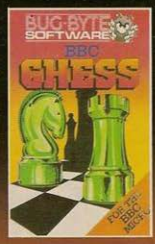

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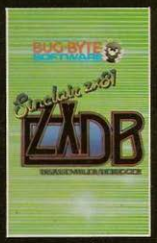

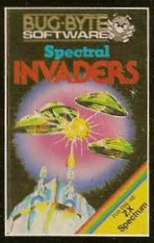

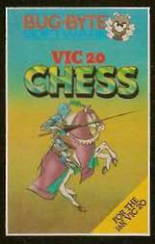

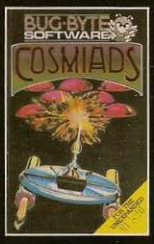

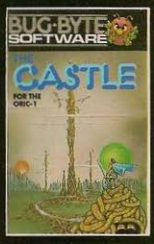

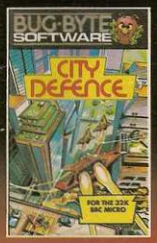

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POPULAR COMPUTING WEEKLY

"Oric is everything you hoped it would be. Alive with colour, and zapping with built-in sound effects, the Oric looks like a match for any machine now selling for less than £200"

YOUR COMPUTER

"The 16k Oric – fighting the 16k Spectrum – is £25 cheaper. It feels a good deal more 'professional' than the home-appeal Sinclair. Oric's sound is extremely versatile, and well up to the standard of the £300 or £400 BBC microcomputer made by Acorn."

WHICH MICRO?

"Oric was over twice as fast as the Spectrum. Surprisingly perhaps the Oric, which initially seemed only faster when performing the simplest of calculations, has come back to beat the Spectrum by a small amount. As the problems get more complex the Oric comes into its own. One final point – in entering the benchmark tests – the Oric was certainly the easiest to handle."

WHICH MICRO?

"This slope coupled with the design of the keys makes the Oric an easy machine to touch-type on. All keys have auto-repeat and there are four keys dedicated specifically to cursor control. It is certainly easier to type on than any of Sinclair's offerings."

YOUR COMPUTER

"Oric will soon be selling a Modem so that Prestel will become available. Owners will be able to accept telesoftware – programs loaded straight down the phone line – eventually electronic mail could come into the home by the same route, and with the addition of a tape recorder the Oric with its Modem could become a telephone answerer and message taker."

YOUR COMPUTER

"One good feature of the Oric is an on-screen reminder in the top right hand corner to show that you've engaged all-capitals mode. So much better than the BB's variety of lights in the corner of the keyboard. The Oric is sound, simple to get along with and offers great expansion potential."

WHICH MICRO?

"When compared to the stogginess of the Spectrum's keyboard this is certainly an improvement. I can't see any Orics failing through bad assembly. If only the £2400 IBM were so easy to use."

WHICH MICRO?

"Instead of the Spectrum's 28 look-up single-character error reports, the Oric has 18 self-explanatory messages. If you actually want to do computing, rather than just exploring the world of off-the-shelf games programme entertainment the Oric will be a better buy."

WHICH MICRO?

"A good speaker and built-in noises get the Oric's sound off to a good start. Typing Zap, Ping, Shoot or Explode produces convincing arcade game noises which can easily be incorporated into any program."

YOUR COMPUTER

"The modem is certainly unusual in a machine of this price. Together with the other peripherals, when finally available, it should make for an attractive package for a small business... surely a match for machines costing much more"

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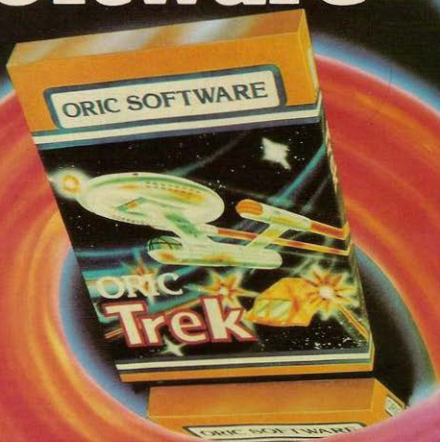

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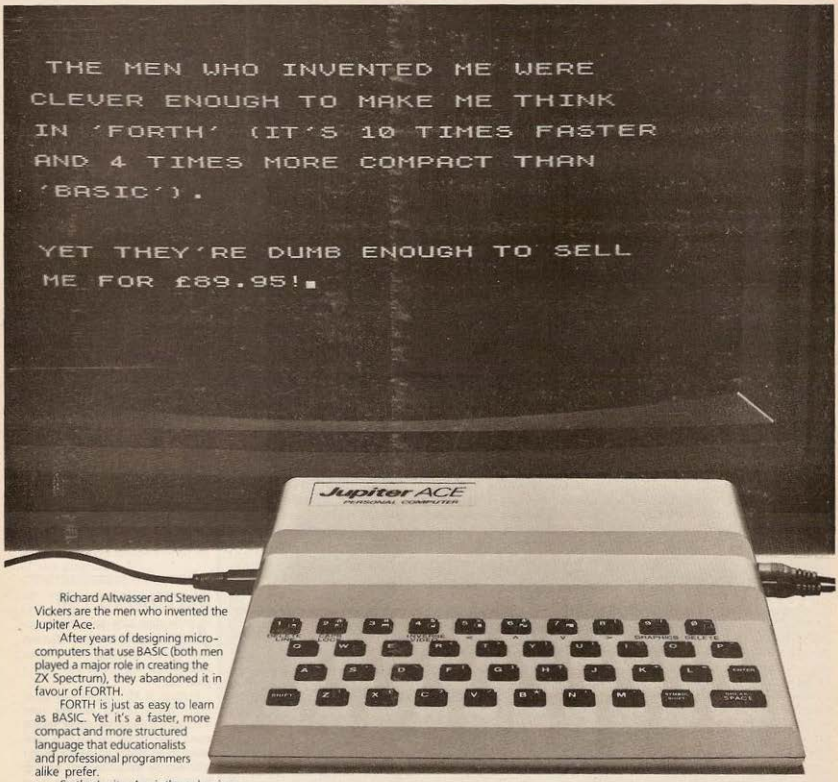

Richard Altwasser and Steven Vickers are the men who invented the Jupiter Ace.

After years of designing micro-computers that use BASIC (both men played a major role in creating the ZX Spectrum), they abandoned it in favour of FORTH.

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It'll take you no time at all to realise how clever Richard and Steven were to design the Jupiter Ace around FORTH. And even less time to realise what a silly price £89.95 is to charge for it.

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YOUR LETTERS

SPECTRUM TV PROBLEM

Many Spectrum owners have not been able to obtain a colour display on certain colour televisions. They have a sharp monochrome display at one position of the TV tuner and distorted colour display at another. My solution is as follows: First, remove the five screws from underneath the casing and turn the computer upright; then carefully lift the top part of the casing so that it is just clear of the circuit board. Move it down over the rest of the casing taking care not to tension the keyboard ribbon cable.

Between the ULA and PAL encoder — see introductory manual page 29 — you will find four adjustable screws. These are used to tune the two separate outputs of the ULA which are related to the contents of the display file and the colour attributes. Next, connect the computer to the television as normal and create a colour display, for example

```
BORDER 1: PAPER 2: CLS
```

Note carefully the initial positions of the screws mentioned previously. Using a screwdriver adjust the top three of these screws until the colours appear on the display, starting with the resistor marked 2.2Kr. If after a period of time the colour disappears then further adjustment is needed. The bottom screw may also be adjusted if necessary. If this procedure fails then return the screws to their original positions. Finally, reassemble the casing, turn over and replace screws.

These alterations are both simple and perfectly safe and should put life into many a Spectrum display.

Mark Nolan, Malahide, Dublin.

MAZE CRAZE

A number of people seem to have had a problem with Maze published in the March edition of *Your Computer* The misunderstanding probably lies in line 5008, which reads

```
5008 LET d$ = "↑ <>v"
```

The string in this line should contain four characters — up-arrow, less-than, greater-than and lower-case v. The symbol in the middle is not the Sinclair unequal sign, although the two look the same on the listing.

In addition, it is worth typing Clear before saving the final version on tape — this prevents all the variables being dumped on to cassette.

Colin Carruthers, Edinburgh.

THE CURE

I built my ZX-81 from a Sinclair kit. After some teething troubles I had about six months of daily use without a hitch. Then the loading problems started. It was hit and miss, the trend became an increasing number of missed loadings. Something had to be done.

All the favourite cures had been tried, different volume settings; cleaner tape passed through; different types of tape; clean heads with meths and cotton wool buds; developed eye ache looking at loading patterns on the screen in an endeavour to interpret them; purchase and use of head demagnetiser.

It may sound silly but I suspect that many other computer "nut cases" are also guilty of not using the Tape Recorder for the purpose for which it was intended. During a bout of frustration I listened to one of my favourite recordings and there was a lot of background hash. At first I accepted the poor signal/noise ratio as the quality standard of the recorder. But I became sure that the recorder did a better job some months ago. What if the computer was upset by this hash? I rooted out a capacitor substitution box and connected between the Ear input and earth of the recorder. The best de-coupling value was found by a marked reduction in the noise.

I obtained a suitable capacitor and soldered it into the recorder. That was over six months ago and loading has been no problem.

G Winterburn, Lytham, Lancashire.

SINCLAIR TRICKS

I have found out three things which may prove useful to Spectrum owners. The first is how to break into programs, which upon loading jump to some machine code. Type in the following.

```
999 Merge "" STOP
```

Load in the program, and when the loading is completed, the computer will display a Stop error code. You now have access to the program. The second, and most useful thing I found out, is how to disengage the Break key.

The trick in doing this, is to Poke down the screen to 24 lines deep at the beginning of your program. At any attempt to break into the program the screen will fill, and the computer will get lost in an endless loop. This happens because when the Break key is pressed, an error code appears. As the computer is used to printing on the bottom two lines, it will not like it if the two lines are not accessible. This results in a crash.

If at any time in the program you do need to re-engage the Break key, include a line which Pokes back to two lines. The pokes are as follows:

```
POKE 23659,0 disengages
POKE 23659,2 re-engages
```

The third thing I found out is how to print on the bottom two lines. The function "Print # 1; "Hello" will print hello on the bottom two lines. This is best demonstrated by typing in this short program.

```
10 Print # 1; CHR$ (RND*127+33):
   GOTO 10
```

Random characters could be printed on the bottom two lines. As the text goes over the line, the area expands to three lines, then to four, and so on. The machine code equivalent of this instruction is RST16, which prints the CHR$ of register A. I hope these few tricks will prove handy to Spectrum owners.

D J Whale, Harlow, Essex.

BBC MONITOR

Richard Harris's monitor program for the BBC Micro published in March *Your Computer* is excellent but happens to have one mistake. The label

```
650 .back DEC &80
```

The monitor can be further enhanced by printing the ASCII values when listing an eight-by-eight block and this is achieved by changing the following lines.

```
40 data1 = P$ + 965:data2 = P$ + 1120:
   data3 = P$ + 1275
50 mess = P$ + 1430:XYmess = P$ +
   1645:pmess = P$ + 1680
60 data4 = P$ + 1685:sptab = P$ + 1755
   :REM SET BASE ADDR OF DATA
```

These lines create the extra space required for new code inserted to print the ASCII values in block print. Following additions are required to achieve this. Replace lines 920 to 1110 with the following:

```
920 .block
930 LDA # 8
940 STA &82
950 LDY # 0
960 .cd LDX # 8
970 STX &83
972 LDA &80
973 STA&84
974 LDA&81
975 STA &85
980 JSR newlin1
990 JSR addrpr
1000 .bc LDA (&80),Y
1010 JSR print
1020 LDY # 1
1030 JSR space
1040 INC &80
1050 BNE ab
1060 INC &81
1070 .ab DEC &83
1080 BNE bc
1081 LDX # 8:STX &83:LDY # 2:
     JSR space
1085 .bf LDA (&84),Y:CMP # &20:
     BCC bw:CMP # &7E:BCC br
1086 .bw LDA # &2E
1090 .br JSR &FFEE
1091 INC &84
1092 BNE bh
1093 INC &85
1094 .bh DEC &83
1095 BNE bf
1096 DEC &82
1100 BNE cd
1110 JMP ff
```

Finally change lines 2430 to 2440 to:

```
2430 .newlin:JSR &FFE7
2440 .newlin1:JSR &FFE7:RTS
```

These changes will allow the user to locate data areas easily and will also help him to look more closely at the BBC OS and Basic Roms. I hope other users find these changes of use.

Deepak Laxman, Godalming, Surrey.

DEFENDING TIM

In response to A Jaques' letter — March edition — Mr. Hartnell was merely pointing out various ideas which the reader may put to good use.

Perhaps if Mr. Jaques had spent many hours of his valuable time writing programs he might understand what piracy can do to a company: his attitude typifies the person who simply wishes to have endless hours of fun without giving those who make it possible their just

NOSTALGIA AND PROGRESS

Thank you for your timely words of wisdom in the March issue editorial in respect of the current low-price computer war.

I own a UK-101, and over several years have upgraded it to 32K RAM, 16K ROM, a multi-dimension screen format including a useful 32 × 64, 8912 PSG, a PIA, VIA etc, with the inclusion of the Cegmon screen editor and machine-code monitor. I was beginning to develop an inferiority complex being restricted to block graphics only. As a matter of interest I ran the speed program in the Oric versus Spectrum article and was pleasantly surprised to achieve Load Array and Sort Array times of eight and 190 seconds respectively taking up 225 bytes of program space and 4041 bytes of variable space. The machine runs at 1Mhz which can also be upgraded.

Instead of buying one of the new plastic-case tortoises I will now return to my steel-clad monster — although not up to the size of the Manchester Mark I computer — and build a high-resolution and colour board with its own RAM leaving me with a full 32K memory less workspace — about 770 bytes — while I wait for the "ultimate" computer.

N L Smith, Stoke-on-Trent, Staffordshire.

reward. If Mr Jaques would look in the March 1983 Response Frame he would see there a letter written by someone who had tried to break into a program to copy it.

I regard *Your Computer* as the most user-friendly magazine available and quite simply the best at helping the user in trouble. Perhaps if Mr Jaques had experienced loading and output problems and suffered the frustration of it all then he would understand how valuable a service *Your Computer* is. I did not find any points technically related to a machine in Mr Jaques' letter.

Michael Gregory,
Guisborough,
Cleveland.

BELGIAN VIC

Living in Belgium, I am the proud owner of a Vic-20. When attempting to load a program from cassette, it can be very helpful to listen to the cassette signals. This can be achieved by simply connecting a standard earphone to the Vic's cassette connector. It does not need an amplifier and cannot damage your Vic at all. Just connect the earphone leads parallel on pin A1 — ground — and pin D4 — read — of the cassette connector. See the user manual on page 151 for the pin configuration. Once connected you will both hear the loading and saving of your programs.

The synchronising header, checks, um, bytes and double storage are three good error-checking techniques used by Commodore to make their tape system very reliable.

Manuel Allaert,
Ostend,
Belgium.

FAST GRAPHICS

I apologise to readers using the machine-code routine described in my article on fast animated graphics for the Spectrum who have found that it does not work correctly when "Width" is greater than 16-bits. The culprit is a missing instruction LD (IX+9), 8 which should come between the instructions EX HL,DE and L4 DEC (IX+8) in listing 3. If you have your original version of the machine-code routine "Animate" on tape, then you should obtain a corrected version as follows: reset RAMtop to 65159 — 48K — or 32389 — 16K — with the appropriate clear command. Load your old version of "Animate".

Enter and run this Basic program:

```
10 Let A = 65160 (32390 for 16K)
20 POKE A + 158, 24
30 POKE A + 159,37
40 FOR B = A+197 TO A + 204
50 READ C : POKE B, C
60 NEXT B
70 DATA 78, 235, 221, 54, 9, 8, 24, 211
80 SAVE "ANIMATE" CODE A, 205
```

Robert Newman,
Oundle,
Peterborough.

EDITORIAL

YESTERDAY YOU WERE impressed by your bargain buy — £200 for a whole microcomputer. Today the smile of the proud new owner fades on your face as you see the same machine at the revised official price of £150. You rush to the calendar: it's too early for the summer sales, and April Fool's Day is long past. Then you recall something you read in last month's *Your Computer:* a Commodore spokesman, when asked to deny persistent rumours that new technology makes the £350 Commodore 64 cheaper to produce than the old £130 Vic-20, would only say that price "was all to do with what the market will bear — not to do with what it costs to make".

This is a clear statement of fact and nothing which should astonish or outrage us. After all British motorists have to pay more than the rest of Europe for the same cars.

Why then should we be surprised to learn that in the vast U.S. market, the ZX-81 — or Timex 1000 — can cost as little as £36 even though most Americans have larger disposable incomes, that the Stateside Spectrum is less than £100 for a machine with a higher specification, and that similar stories can be told about Ataris, TI-99/4s and any other micros you care to name?

You remember being told and not believing that the components inside a Spectrum could cost Sinclair as little as £15 and you begin to wonder if the £50 price cut after you bought your micro could just as easily have been £75 or perhaps even £100.

Before writing off micro pricing as a black art, you should understand how it works. Prices drop because products are in competition with newer or cheaper technology. If a micro-maker has the skill to be first on the market with a new kind of product, that company can inflate the asking price to as high a level as it believes the market will take. Then, as the competition arrives to share the pickings, the first company will deflate the price to try and increase the volume of sales and so maintain or even improve profits.

As the market grows, production costs tumble partly because the more integrated circuits the chip-builders produce, the smaller the percentage of faulty circuits — and that means increased yields and lower unit costs. Of course you can come a cropper if the original price is too high. The excellent TI-99/4 was the first 16-bit colour home micro and cost about £750 when it was introduced in 1980. As other machines appeared, the TI-99/4's price had to be dropped progressively to its current level of £150 to remain competitive with the newcomers. Some would argue that its original price asked too much of the U.K. market and damaged the micro's prospects in the long run. A £350 price tag for a machine of such a calibre in 1980 might have given the TI-99/4 a vast user and software base in Britain.

Clearly there are concealed costs beyond the price of components. Companies have to allow for research and development, labour, production overheads, packaging, distribution, marketing, margins for retailers and even the expense of maintaining the jammed switchboard of the customer complaints department. But when you add all that up, the gap between costs and price can still be very large. Perhaps that explains why so many new companies are bravely rushing into computing to fill the breach.

How to write for *Your Computer*

We called this magazine *Your Computer* precisely because we welcome your views, tips and hints and even your criticism of machines and software in general. If you would like to see your name in print, whether on a Software File program or a full-blooded article, here is how to go about it. Ideally, all articles should be typed double-spaced on one side only of uniform sheets of paper. If listings can be dumped directly from a printer — you can always use a friend's or user group's — this minimises the risk of error. In a perfect world a cassette would accompany the article. That considerably speeds up the checking process. Not only do you get to air your own discoveries and opinions, but we will even pay you for the privilege. We pay £35 per published page — that's as it appears in the magazine and includes illustrations.

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Premier disc system — a first for Dragon 32

NOW THERE IS a disc system for the Dragon 32. Premier Publications has incorporated a Disc Operating System and disc controller in a single cartridge which plugs into the games cartridge port.

The Disc Operating System supplies a comprehensive set of commands which appear to the user as an extension of Basic. As well as standard facilities for creating and deleting files, reading the directory, disc formatting, renaming files, there is also provision for opening up to eight random and sequential files simultaneously.

Two unusual features are the Find and Config commands. Find enables data files to be searched for a string match. Config allows the user to configure the system to run with almost any type of floppy-disc drive available. The number of tracks, sides and sectors per track on a disc can all be specified to allow the system to support 3, 5.25 and 8 in. drives. In addition the controller cartridge can cater for up to four drives at a time, in any combination.

The cartridge comes with a 74 page manual and costs £99.95. Premier Publications is also selling complete systems, starting with the Delta 1 at £299.95.

This includes the controller, cables, and a 40-track Canon disc drive with a capacity of 100K.

Premier Publications is at 208, Croyden Road, Anerley, London SE20 7YX.

Millionth U.K. micro sold

THE END OF APRIL marks a milestone for home computing — with the sale of the home computer in Britain. There are more ZX-81s out there than anything else followed by Spectrums, Vic-20s, BBC Micros, Dragons, TI-99/4s and a dozen other computers.

BBC Music Processor

QUICKSILVA MUSIC Processor turns your BBC Micro into a tape recorder and synthesiser for just £14.95, Andy Williams the author of the program, started working on it in May last year. He says that if he had worked full time it would still have taken him six months to complete.

Business Press

THE NAME of *Your Computer's* parent company has been changed from IPC Business Press Ltd to Business Press International Ltd. This change has been made to reflect the very wide range of markets covered by the 100 publications of the company, and to identify its prime position as the world leader of business publishing.

Spectrum goes organic while ZX-81 grows to one megabyte

THIS MONTH Basicare is releasing an interface which will enable Spectrum owners to use most of the modules in the company's Organic Micro system which is now available for the ZX-81.

These include a CMOS RAM module backed by battery for non-volatile program storage, Toolkit, an interface to take up a 8K of utility programs stored in EPROM or ROM, and a sound synthesiser module. There is also a general purpose interface providing 24 input/output lines and a Centronics interface to link the ZX-81 or Spectrum to most printers.

On the ZX-81 the printer interface is accompanied by a program which prints ZX-81 graphic characters on Epson and Seikosha printers.

The modules can be stacked on top of each other and are interfaced to the computer through the Persona module which communicates with the other devices via a 64-way bus.

One feature that sadly will not be available for the Spectrum is the Minimap module. This enables ZX-81 owners to access up to one megabyte of RAM. Only 64K can be read at one time but up to 16 pages of 64K can be switched in and out using a single Poke instruction.

Analogue to digital, and digital to analogue converters for both the ZX-81 and Spectrum will also be released. Future developments include a joystick controller and a fast cassette loading device.

The Personal module costs £30.25 and the Minimap £35.95. Prices for the other devices range from £22.20 for Toolkit to £76.25 for 64K RAM. Basicare is at 12 Rickett Street, London SW6. Tel: 385 2135.

Spectrum owners can now link their micro up to the £149 Tandy colour printer. Softest is selling an interface package for £35. It includes the necessary hardware together with cables and three programs which allow user to access the Tandy printer commands. A high-level driver program to make graph plotting easier is under development and will be available for £5.00. Softest is at 10 Richmond Lane, Romsey, Hampshire, SO5 8LA.

Ikon's Hobbit for the BBC Micro runs rings around conventional cassette storage

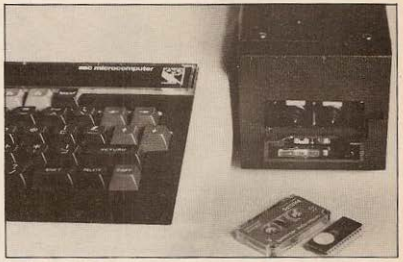
YOU'VE READ THE BOOK, you've seen the film, now buy the floppy tape drive. Hobbit is the name of a new storage unit for the BBC Micro which is faster than cassette and cheaper than disc storage. It reads and writes at almost seven times the rate of the standard cassette, and also offers many of the housekeeping facilities of a disc system.

Ikon Computer Products, which makes the Hobbit is supplying it with an EPROM which contains the floppy tape equivalent of a disc-operating system and takes care of such tasks as locating a program on tape and updating a directory. All of the standard BBC file commands are supported as well as a few extra commands which are specific to the Hobbit.

The Hobbit has similarities to Sinclair's Microdrive but whereas the Microdrive will use a continuous loop of tape, tape on the Hobbit can be moved backwards and forwards. The average access time is 20 seconds with a maximum of 90 seconds.

Two drives can be connected to the BBC through the user port. Each takes a cassette with a capacity of 60K per side.

Perhaps Ikon should have considered calling the £155 Hobbit after another furry animal — the rabbit in *Magic Roundabout* — because Ikon is based at Kiln Lake, Laugharne, Dyfed — which used to be the home of Dyan Thomas.

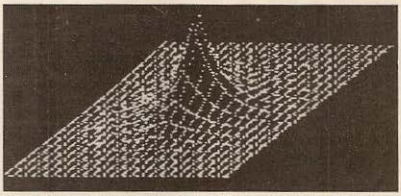


High resolution Sinclair tape from self-taught schoolboy

RICHARD TAYLOR, a 14-year-old schoolboy, has found a way to improve the ZX-81's 64×44 pixel resolution without using any extra hardware. Until now high resolution on the ZX-81 could only be obtained from high-res graphics boards costing over £50. Richard Taylor's program, High Resolution, comes on a cassette and gives a resolution of 256 by 192.

The program takes up around three-quarters of a K and creates its own display file which consumes a further 6K. It allows you to plot points, invert points, save and load a high-res picture, and also to define new characters.

Like most of the other programming whizzkids Richard Taylor is entirely self-taught. He finds rewriting the operating system easier than devising games. "There is no point in doing what everyone else is doing", he explained and added "I like to make a machine do what it's not designed for". He has now moved on to the Spectrum and is working on a program to give the Spectrum a genuine 36 colours.



The High Resolution program costs £5.95 and is available from Computer Rentals, 140 Whitechapel Road, London E1.

Android Attack on the trail of Dragon Donkey King

FLUSHED WITH the success of its top-selling Dragon program Donkey King, Microdeal has now released five new programs for the Dragon. Android Attack is based on the arcade game Beserk, includes some limited speech synthesis and routinely announces intruder alert or charges the player with cowardice. Galactic Ambush and Cosmic Zap are Microdeal's versions of Galaxians and Space Fortress. Program packs 4 and 5 each contain nine short programs. These tapes are available from Microdeal and Dragon dealers for £8 each.

Remember the MPF II — the £269 colour computer we scooped last October? At the time our reviewer complained that it was a good machine let down by a dreadful keyboard. Here it is with the £36 full-size keyboard, joystick, £185 thermal printer and some software all of which are now available all over the country from the Spectrum dealer chain.

80K for £300 coming soon

LATE NEWS of an 80K home micro about to be announced by one of the world's biggest micro makers. The machine will set new standards in BBC Micro, Commodore 64 country and will cost around £300. More details next month.

YOUR COMPUTER TOP 20

Game	Company	Machine
Arcadia	Imagine	Spectrum
Choplifter	Creative Software	Vic-20
Choplifter	Broderbund	Atari
Donkey King	Microdeal	Dragon
Dragon Trek	Salamander	Dragon
Flight Simulation	Psion	Spectrum
Flight Simulation	Psion	ZX81
Hobbit	Melbourne House	Spectrum
Kong/ Dracula	Tony Barber	ZX81
Moons of Jupiter	Romik	Vic-20
Penetrator	Melbourne House	Spectrum
Planet Invasion	Microdeal	Dragon
Rocket Raid	Acornsoft	BBC
Sea War	Panda	ZX81
Synapse	Fort Apocalylpse	Atari
Snapper	Acornsoft	BBC
Time Gate	Quicksilva	Spectrum
3D Defender	New Generation	ZX81
Traax	Llamasoft	Vic-20
Zaxxon	Datasoft	Atari

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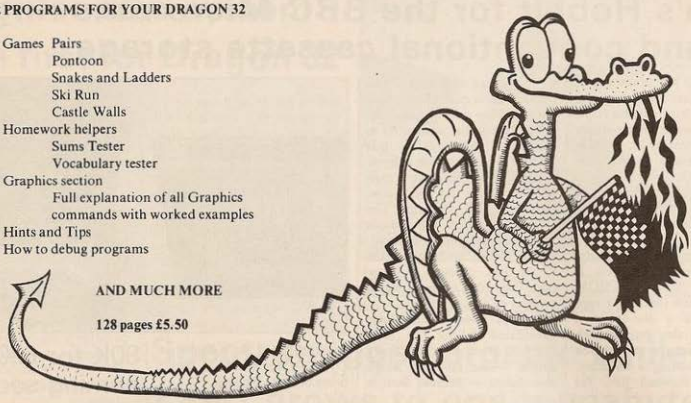

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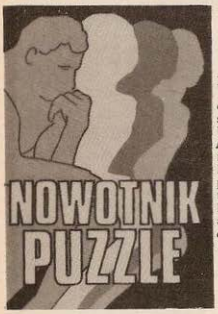

For either the 16K Spectrum or 16K ZX81, this is an original challenge for anyone. The screen becomes the playing board for this addictive puzzle. ***Machine coded*** for smooth and instant responses, it offers four levels of difficulty. The computer breaks and shuffles a two-by-two coloured square - have you the skill and mental agility to restore it? ***"Very addictive"*** – ZX Computing Feb/March 1983.

KNIGHT'S QUEST

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Acornsoft Castle of Riddles: the knights errant receive rewards

From left: runner-up C P Bignell; *Your Computer* editor Toby Wolpe; winner Peter Voke; Acornsoft's David Johnson-Davies; and in third place P K Colbert.

A DAWN CROSS-COUNTRY DASH from Littlehampton on the Sussex coast to *Your Computer's* offices on the outskirts of London just failed to clinch first prize in the £3,000 Castle of Riddles competition for 34-year-old company director Colin Bignell. Only 20 minutes before Colin Bignell's car drew up outside the *Your Computer* headquarters, Peter Voke of Aylesbury, Buckinghamshire was safely delivering the winning entry into the hands of editor Toby Wolpe.

Third past the post was Peter Colbert, a Cardiff-based British Telecom programmer. He put his faith in his colleagues at the Royal Mail and entrusted his entry to the vagaries of first-class. He had solved the riddles in six hours — two hours faster than the other prize-winners. Both he and Colin Bignell each receive £400 of Acorn equipment, while Peter Voke won the £700 silver "King of the Ring" trophy and £1,500 of Acorn hardware.

At the top of his shopping list is a dry ink-jet printer, followed by a small disc drive and a second processor. The two runners-up have set their sights on disc drives, although Peter Colbert also finds the voice-synthesis chip a very attractive proposition. His six-hour session that solved the Castle of Riddles started on a Saturday morning and ended early in the aftrnoon of the same day.

Although the cassette had arrived two days before, his wife was against his spending all night at the keyboard.

Away from the cut and thrust of the world of adventures, "King of the Ring" Peter Voke confides that time spent away from the keyboard and, above all, moderation are his keys to success. He recommends sleeping sensibly — would-be champions should note that throughout the time he was wrestling with the Castle of Riddles he made sure he got his 10 hours a night.

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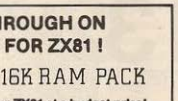

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Dec/ Jan Issue. Program Features: Space City (invader type game), Breakout, Artist (joystick painting program), Rescue (miraculously retrieves program after Bad Loading or "Bad Program Message") and Pack — a program to compact basic programs and disc system review. Software reviews — including Wordwise, Book reviews, adding Joysticks, Interface to Model A. How to assess the video controller chips and ideas for the newcomer, plus a new crop of hints and tips.

February Issue: Program Features: BEEBMAZE — Find you way through the random maze, guided by 3D views from inside the maze — an excellent game. FIVE-DICE — A Beeb implementation of YAHTZEE (R), a novel dice game. Also a listing of WINDY FIELD — a creation from Acornsoft. SPIROPLOT screen doodler, and a complete memory display program in a user key. Plus Machine Code Screen Dumps for the Epson and Seikosha Printers; articles on USING FILES, IDEAS ON ANIMATION (including a Rotating Cube program) an Introduction to the use of Procedures, a Survey of Books on the BBC Micro, and a Roundup of Disc System Hints. PLUS a variety of HINTS, TIPS AND INFO, including a single VDU command to perform a SIDEWAYS SCROLL. WIN A COLOUR MONITOR, WORDWISE WORD PROCESSORS AND ACORNSOFT GRAPHICS BOOKS IN OUR THIRD SOFTWARE COMPETITION.

March: Program Features: Life (32k), Artillery Duel (16k-32k), Square Dance, 3D Rotation (will rotate any object). Microsketch (16k) screen drawing program in only one line of code. Printers for the BBC micro — Review of Epson, Seikosha, Tandy and Olivetti. What to do with the new Operating System Chip, Disc Formatter Program, and full Disc Instruction set. Newcomers article on Text and Graphics Windows.

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STOP PRESS

BEEBUG has negociated a deal with ACORN over the new 1.2 OPERATING SYSTEM ROM. BEEBUG members are offered the ROM at around half price. See BEEBUG Feb issue for details.

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Computer Club is here to encourage you to start your own local computer club or, if one already exists, to join it and become involved. We would like to hear of anything which has made your club a success, or of any projects or programs you are developing.

BIRMINGHAM CALLING

Birmingham is not only the venue for our Midland Computer Fair at the end of April — it is also the home of a computer club which can be heard broadcasting on local radio. Simon Beesley tunes in to West Midlands Computer Group.

FOR A SMALL club the West Midlands Computer Group is remarkably productive. It puts out a monthly magazine, Databus, has its own 15-minute slot once a week on Radio West Midlands, and also produces its own software. Databus packs into 10 pages a useful mixture of news, articles, programs, programming and software reviews — all contributed by club members.

The driving force behind the club is David Thomson who founded it last August. He teaches at a local school and was initially concerned to provide a forum for the computing interests of pupils once they had left school. He was assisted by three of his ex-pupils in setting up the club.

The three in question are all talented programmers and are considering marketing their software. With the present boom in commercial software sales no doubt it will not be long before they are rubbing shoulders with the Bug-Bytes and Quicksilvas of the business. *Your Computer* — ever quick to spot new talent — can boast that we gave one of them, David Griffin, his first break when we published his game Maze Munch in our December issue. This program for the BBC Micro was one of our most popular and as an amateur programmer myself I was rather disconcerted to learn that it had taken David Griffin just one hour to write.

From its connection with David Thomson's school the club has now broadened out and, according to Databus, includes no less than three astronomers among its 36 members. One of the astronomers uses a ZX-81 to control the movement of his telescope.

Most of the machines in evidence were BBC microcomputers. Holding its own with the BBCs was a customised ZX-81 in full concourse trim, complete with an add-on keyboard, a wooden casing, a Qsave tape-loader and Atari joysticks.

David Thomson suggested that one of the reasons for the BBC Micro's popularity among computer club enthusiasts was the extensive facilities it offers for communicating with the outside world. His own interests are concentrated, as he put it, on the back of the computer and he writes a regular series in the club's magazine on control applications.

At this meeting he demonstrated how to write to the user port on the BBC. Another member had brought along a board fitted with LEDs which plugged into the user port and showed which control lines were in operation.

Elsewhere in the room David Berry, the club's ZX-81 expert, turned his hand to showing a beginner how to write the software which would read joystick inputs on the BBC.

Another group was taking an unconventional approach to adventure games. One of the members had cracked the code which Acornsoft adventure programs use to store their phrases and sentences. He had with him printouts of all the responses that the computer could give in the Castle of Riddles and Philosopher's Quest — a philosopher's crib sheet.

As can be seen, within an informal framework, the West Midland Computer Group's activities are varied and enterprising. The club meets once a month in the Victorian splendour of a room at Birmingham's Central Hall. For more details you can contact David Thomson on Bromsgrove 32242.

Members of all ages cracking an adventure game.

Local society news

Basildon buffs

THERE is now a microcomputer club for the Basildon area. It meets fortnightly on a Tuesday evening at Healey Management Services, The Hemmels, Laindon, Essex. You can telephone Roger Sims on Wickford 63032 after 6.30pm.

Thurnscoe micros

AROUND 70 people attended the first meeting of the Thurnscoe and District Microclub in March. Not all were owners but a straw poll revealed interests in a wide range of machines, from the Spectrum and the Dragon to the Pet and Nascom III. Meetings are held every Wednesday evening at Thurnscoe Comprehensive School, Clayton Lane, Thurnscoe, South Yorkshire. For further information contact Peter Davis on 0709-893880.

Liverpool users

SINCLAIR owners in Liverpool can attend meetings of the ZX Users Club every Wednesday evening at the ZX Computer Centre, 17 Sweeting Street, off Castle Street, Liverpool 2. Anyone is welcome whether they have software or hardware problems, an interest in programs and games, or just a general interest. More details can be obtained from Keith Archer on 051-260-4950.

Enfield brigade

ENFIELD Computer Club caters for the novice and expert alike. Meetings are held on the first and third Monday of each month at Brigadier Youth Centre, Brigadier Hill, Enfield, Middlesex. The annual membership fee is £2 and a further 25 pence is charged at each meeting.

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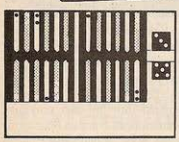

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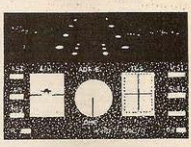

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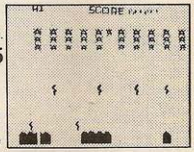

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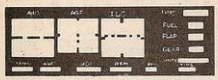

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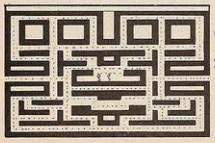

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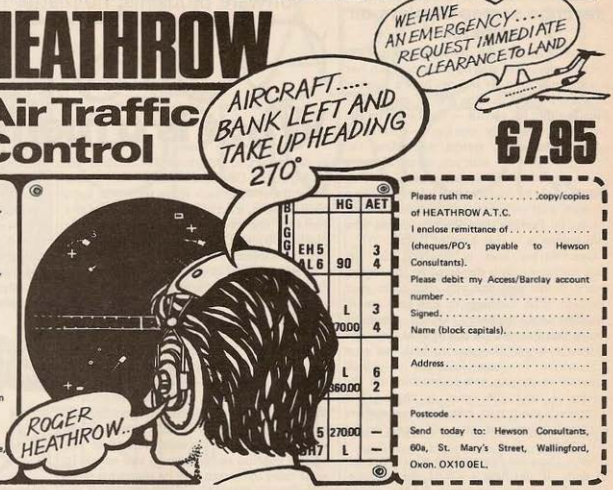

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QUESTIONS

What is a memory map?

'What does the term memory-mapped mean? I have seen it used to describe screen displays on computers.'

YOU CAN THINK of the computer's memory as being composed of a series of boxes. Each box is a memory location and can hold a number between 0 and 255. One area of memory — usually either 8K or 16K — is set aside for the computer's read-only memory" — ROM — which contains the system that allows the computer to interact with you, do calculations, put things on the TV screen, and so on. This area can only be read from, so it is rather like a jar with a lid on because you can see what is inside, by Peeking, but you cannot put new information in — that is called Poking.

One further area is reserved for the information which is displayed on the screen, and it is this area that you refer to in your question. The locations in this case are in "random access memory" — RAM — and this means that information can be read from and written to them. So you can both put new information in these locations — which amounts to putting new information on the screen — and see what is there. The computer's electronics translate the numbers in these locations into what will appear on the TV screen.

Now, there are two ways in which this can be done. If you have a ZX-81, for instance, you will find that the screen RAM — often called the Display File — contains the Codes of the characters which are to be put on the screen. It does not hold information about each and every dot — or pixel — on the screen.

This may be called a character-mapped screen. Before printing a character the computer needs to consult a section of ROM known as the character generator, which stores the dot patterns for each character.

On the other hand, owners of machines such as the Spectrum, Dragon or BBC Micros will find that the Display File holds information about the rows in each character — the bytes on the screen, where there are eight bytes to a character and every byte is eight dots — or pixels — wide. This is sometimes referred to as a bit-mapped screen since each pixel on the screen is assigned to a bit in memory.

If your computer's screen is truly memory-mapped this will mean that there is a set, unmoveable area of memory put aside by the micro. In the case of a character-mapped screen about 700 locations are reserved, and for a bit- or pixel-mapped screen the area will be at least eight times as large.

The number stored in the first location in the screen RAM usually determines what will appear in the top left-hand corner of the screen, the second location relates to the second position on the screen, and so on. In some cases the screen may be somewhat more complicated than this — as owners of the Spectrum may have discovered.

Sometimes, however, a computer will not set aside a fixed area but will instead keep enough locations free somewhere within its RAM — with a pointer to the start of this area being kept in a known place. In othr cases, and Camputers' Lynx is one example, the screen's memory may be quite separate from the RAM which is available to the programmer. In such cases the Display File may be in separate memory chips which cannot easily be read from or written to.

Lastly, some micros put aside a varying amount of memory for the screen depending on whether a text or graphics display is chosen. This may amount to your having the choice between a memory-frugal Text mode and a memory-consuming Graphics mode — the Oric 1 and Dragon 32 are just two examples here.

Tim Langdell

I could do that...

Amstrong numbers are numbers that are equal to the sum of the cubes of their digits. For example, 371 is an Amstrong number since $371 = 3^3 + 7^3 + 1^3$. Write a program to output all the Armstrong numbers between 1 and 5000.

We were a month early in picking the winner of March's competition in April. Future First Byte competitions will be judged two months after they are set an closing date for entries is the last working day of the month in which the competition appears.

BEATING

PUT A REM

ONE OF THE advantages of writing your own programs, as opposed to typing other people's in, is that at least you know what the machine is meant to be doing — so debugging certainly should be easier. But it is amazing how quickly you can forget what a particular bit of code is trying to achieve.

One of the most powerful weapons in the debugger's armory turns out to be the lowly Rem statement.

This is very useful if it merely tells you what

KEYING IN

ALL VERSIONS of Basic allow you to enter information from the keyboard with Input. When Input is reached the program waits for you to enter something before continuing. It allows you to enter several characters at the same time and edit them before Input, but has the disadvantage that you must always follow your last character with Enter, which is slow and can be a nuisance when you only need to use a single key in both games or serious programs.

The alternative way of getting information from the keyboard, which is found in many Basic dialects, is the Inkey$ function. This can continually scan the keyboard and tell you instantly when a key is pressed. Inkey$ is also particularly useful in high-resolution graphics modes as it does not send you striaght back to the normal text screen as Input does. As the program does not automatically stop and wait for you to do something a loop must be made around Inkey$ which is only left when a key is pressed:

```
10 A$=INKEY$
20 IF A$="" THEN 10
```

Note that Inkey$ always gives you a String variable, and that the sign for an empty string is double quotes and a full stop.

If you want to enter a number and use it for calculations then you must convert the string into a numeric variable with the Val function:

```
30 A=VAL(A$)
```

If you want to use cursor keys to continuously control left and right movement you can convert the Inkey$ string to its ASCII value — 8 for left and 9 for right — and then simply add on the left and right movements to the current position:

```
30 A=ASC(A$)
   (or A=CODE(A$) on Sinclair)
40 POSITION=POSITION + ((A=8)-(A=9))
```

Keith and Steven Brain

Lynx winner, Dave Bull giving his two-year-old son early keyboard experience. Competition details on page 183.

Relational and logical operators may sound awesome, but a computer would be lost without them. Here we explain them as simply as possible.

ALL ABOUT OPERATORS

A COMPUTER CAN only tell the difference between off and on. Sitting on the fence is not possible. It is therefore totally logical in the way it makes decisions, although of course it can only decide between options which you have decided to include in your program. All decisions are based on testing whether a particular condition — or test — is True or False. Many decisions can be made using only the simple relational operators:

=	equal to
>	greater than
<	less than
<>	not equal to
>=	greater than or equal to
<=	less than or equal to

Both numbers and strings can be compared, but with strings you must make sure that there are no invisible spaces hiding at the end of words. If you test whether

"FIRST " = "FIRST"

then the answer will be no, and similarly "BYTES" is not the same as "bytes". The last two relations are not absolutely necessary, particularly when dealing with numbers, as it is often as easy to write a program which does not need them.

```
10 IF A>= B .......
```

is equivalent to:

```
10 IF A > (B-1) .......
```

Comparisons of conditions may be made more exhaustive — not to say exhausting — by including the logical operators And, Or and Not which combine several tests together in a single program line but can become rather mind-bending.

The first logical operator, And, should be easy enough to understand,

```
IF test 1 AND test 2 TRUE then whole test
   TRUE
```

If both test 1 and test 2 are true then whole test is true but if either test 1 or test 2 is false the whole test is false:

```
10 IF TEMP = 0 AND DAY = 7 THEN
   STAY IN BED
```

and Or is not too bad either,

```
IF test 1 OR test 2 TRUE then whole test
   TRUE
```

that is, if either test 1 or test 2 is true the whole test is true:

```
10 IF MONEY = 0 OR SHOP = SHUT
   THEN HARD LUCK
```

but Not often causes chaos as it looks at first sight as if it works backwards.

```
IF NOT test 1 FALSE then whole test
   TRUE
```

If test 1 fails then the whole test is True: although the sense of the logic can be seen if you consider:

```
10 IF NOT (DAY=PAYDAY) THEN NO
   MONEY
```

Keith and Steven Brain

THE BUGS A STATEMENT IN IT

each bit of the program is doing. For instance:

```
REM PLOT VALUE
```

or

```
REM ASK NEXT QUESTION
```

Many errors show up immediately you read through the program, because what the Rem say and what the code is obviously doing are quite clearly different.

Rems are also very useful for keeping track of what you are using your variables for. It is a good idea to set aside the first 100 line numbers of each program for Rems, mainly to describe variables. Each time you add a new variable, go back and write a Rem saying what it is for:

```
40 REM H IS HEAD POSITION
50 REM T IS TAIL POSITION
```

A good way of developing your own bug-free programs is to keep running a program as you type it in. Apart from making the whole process more interesting, most errors are thrown up very soon after you have typed in the lines causing the problem, so it is easier to sort things out.

Another way of developing programs which makes tracking down errors easier is to make use of "stubs". This approach lets you sort out the main point of the program first, and the fiddly bits are sorted out later. A stub is a subroutine which does the fiddly bit in a provisional, simple way.

For instance, if each time an object hits the side of the screen you want to make an elaborate noise, you can put in a Rem

```
REM GO AND MAKE ELABORATE NOISE
```

at the appropriate point in your program. Under the remark you put a Gosub instruction off to a high line number, and at that line number you put a very simple routine which merely makes a feeble beep and then Returns.

When you run the program you will know that the noise is occurring in the right place, and you can give your full attention to sorting out the rest of the program.

It makes sense to put all your subroutines together, separately from the rest of the program flow, perhaps at the end of the program, with very high line numbers, say over 10,000. With some machines it is better to put them at the beginning, especially if the subroutines are used often, because the Basic interpreter may take longer to find line numbers towards the end of the program.

With subroutines it is especially important to include plenty of Rems, as you may be calling a particular routine from several different points in your program.

If you are adding lines to a program to help you write it which you intend taking out later — either Remarks, or perhaps Print statements — it is important to be able to get them out without introducing new errors. A very common error message is

```
UNDEFINED STATEMENT IN LINE n
```

which is caused by branching to a non-existent line. Sinclair Basic is unusual in that it lets you get away with this, assuming you mean the next highest line number.

To help me keep track of lines I might want to get rid of, I give them odd line numbers. Usually I use only even line numbers, and go up in increments of ten. So if I see a line 51 in my listing I am automatically suspicious about it once I have finished testing a program.

With Rems it is also easy to put recognisable characters in the line, for instance a string of asterisks, so you can find the lines you want to pull out easily later. Remarks do not have to be on a line of their own, and can be used after a colon to flag other testing lines. *Ian Stobie*

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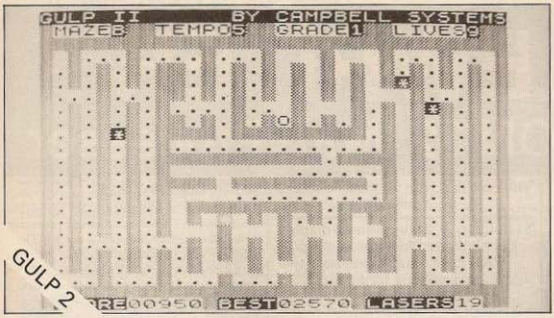


SURVEY

All systems are go as Peter Connor explores the weird and wonderful lengths to which software houses go to create programs for the ZX-81.

IT IS NOT easy to review software for the ZX-81 without using the weary old disclaimer "Given the limitations of the machine . . .", and I am not going to try. These limitations, as every owner must be well aware, are the primitive graphics and the absence of sound or colour. The limitations, of course, are far outweighed by the advantages; at about £50 the ZX-81 made home computing available to practically anyone who wanted it. After all, £50 is only 50 packets of cigarettes, or for younger readers about 350 Mars Bars.

To produce a version of Scramble, then, for the ZX-81 might seem as hopeless as trying to paint the Forth Bridge with a toothbrush. Yet it works surprisingly well. In Mikro-Gen's version all the usual features are there: the rugged terrain, guns, missiles and smart bombs, the different defence zones. If your gun seems to fire more like a peashooter than a Mig-21 you must remember that, given the limitations of the machine, this game is pretty good value.

Another old favourite produced for the ZX-81 is Invaders. Silversoft's and Bug-Byte's versions are, understandably, very similar. Both have different skill levels and the rather chunky aliens come fast and furious at the highest level. At the lowest level the games have a strange slow-motion effect, as if the invaders were on tranquillisers.

One thing games on the ZX-81 bring home to you is the magical and often hostile properties of letters. In Mikro-Gen's Tempest, a clever variant of Scramble, you have to survive as long as possible against the alien Spinners, Liners, Walkers and Asteroids. These aliens are none other than wandering letters and symbols; it is rather like being under attack from a psychotic typewriter keyboard. The Walkers — Ws — wander all over the screen while the Asteroids — formerly friendly asterisks — come straight at you. More dangerous than either of these are the Untouchables, one of whom bears a remarkable resemblance to the space bar. If you do not use your smart bombs, they will crush you. The game is in five sectors, through which the aliens increase in speed. The pleasing thing about Tempest is that Mikro-Gen have made necessity the mother of invention and used the ZX-81's simplicity to create a game of almost surreal charm.

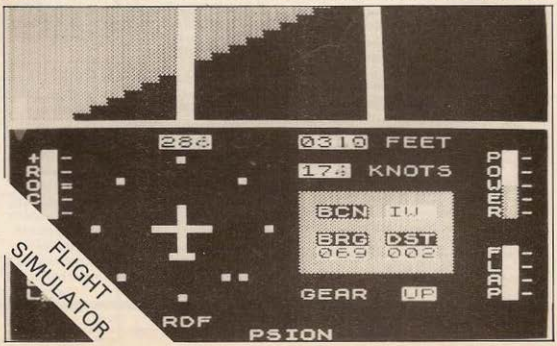
Galaxians from Quicksilva has something of the same interest. Here, the first wave of swooping aliens consists of flying Vs. But if you think those are dangerous, you'd better look out for those Ws lurking at the top of the screen. W is a genuinely nasty letter. Given the limitations et cetera, et cetera, Galaxians is a good version of the standard game. It is fast and if you miss the sound effects you could always make them yourself.

Several other arcade favourites are now available for the ZX-81. DJL Software has produced Frogger and Psion has the same game as Frogs. Both are good versions, with the logs really rolling at the highest levels. DJL's version, though, has the slight edge; as the game progresses you encounter the additional hazards of snakes and alligators. There is also the extra task of rescuing cute baby frogs from the logs on your way across. It is heartening to see software houses encouraging a sense of civil responsibility.

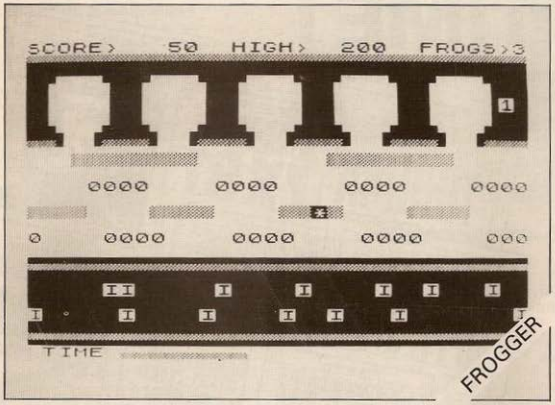
Personal Software Services — PSS — has a Krazy Kong game on the market. You have to climb a pyramid and knock out Kong's support. Obstacles to succeeding are barrels and fireballs which you must jump over on your way to Kong at the top. The graphics are good and make Kong a lively and exciting game.

What seems to be the only version of Centipede for the ZX-81 has been produced by Llamasoft. This is a very distant relation of the Arcade game. Rather than threading its way through a forest of toadstools the centipede is unimpeded and descends too quickly.

Two games which are deservedly best-sellers are Gulp 2 from Campbell Systems and Flight Simulation from Psion. Gulp 2 is similar in quality to the version available for the Spectrum, which means it is very good indeed. It is similar to Pac-Man in that your man has to eat the dots in the maze while being pursued by hostile monsters. What is impressive, though, is that there is a choice of fifteen different mazes; you can even have one in the shape of the letters ZX-81. The speed can be set, there is a choice of two keying systems, and the game will give you a demonstration before you begin. It is not hard



ZX-81 SOFTWARE



FROGGER

to see why this game has proved so popular.

Flight Simulation is just what the name says — a realistic and complicated simulation of flying. You have to direct your plane to the airport and then land it. There are two separate displays. The first is a cockpit with a view of the horizon and control panel. The second is a map showing your position relative to the landing strip, which enables you to navigate.

It takes quite some time to master the technique of landing since you have to co-ordinate height and speed then bank and dive to your death watching the horizon sway sickeningly through the cockpit windows. The more sophisticated will take the time to master the techniques of flying and landing, perhaps so that they can take over when the pilots of their Boeing 707 die from food poisoning.

But software does not have to be as complex as this to be enjoyable. Psion also markets a version of Breakout called Thro' the Wall — on the same tape as their Scramble. It is just as you would expect; a bat, a ball and a wall of bricks. The simple pleasures of this game take one back to the days when a computer ping-pong machine was as awe-inspiring as the first sunrise. The uncomplicated principles of games such as Breakout might guarantee their existence in an age of ever more noisy and baroque programs.

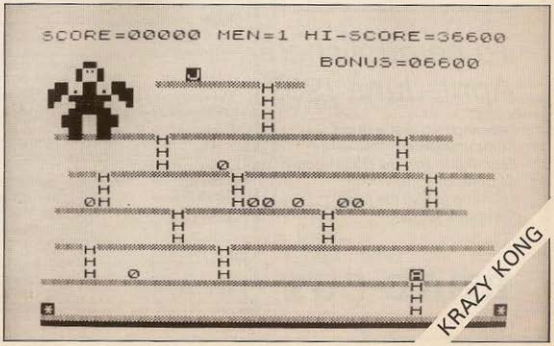
Amba Software has two similarly straightforward games; Trap and Hunt. In the first you play an opponent, or the computer, and have to block off areas of the screen by drawing lines. In Hunt, again a two-player game, you chase numbers in a maze; as time runs out the value becomes smaller. There is something compulsive about Hunt, involving as it does, the race against time and avoiding obstacles.

Adventure games are one field where the ZX-81 does not lose much by comparison with more powerful machines. This does not mean that games for the ZX-81 are different or better; on the whole we get a tepid goulash of the same leftovers. Fantasy games from Psion offer two adventures, Perilous Swamp and Sorcerer's Island. The deep stagnant pools of the first sum up the whole world of the adventure game. The princess, the evil wizard, the slimy green bunyip, the horrible dirty troll; love them or hate them, you cannot play an adventure game without them.

At least, it seemed you could not. Dictator, from Bug-Byte, looked like a welcome exception. Here, you are President for life of the banana republic of Ritimba. In this somewhat amoral game you have to exploit the country for your own good and then make your escape before the guerillas, or other opponents, get you. However, the colourful blurb and drawings flatter only to deceive. When you settle down to be a ruthless and evil megalomaniac you will be disappointed by the dullness of the game itself. Quicksilva, though, has succeeded in finding something different. Trader — in three parts — is more of a semi-adventure game; there are the usual decisions to be made, but also tasks such as piloting your ship or finding your way through a maze.

The variety of activities and the clever graphics make this much more entertaining than the usual adventure. Your objective, of course, is to make a huge profit by trading with the inhabitants of the Meridien system, all of whom have different needs and characteristics. The Psions are immensely intelligent beings, constantly rearranging the blobs which constitute their bodies. They are con-

(continued on page 45)



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(continued from page 43)

temptuous of human intelligence and, before doing business with them, you will have to answer their questions correctly. With Betans you must bargain. With the robotic Alphans you can only take it or leave it. On Delta though, you can make a killing.

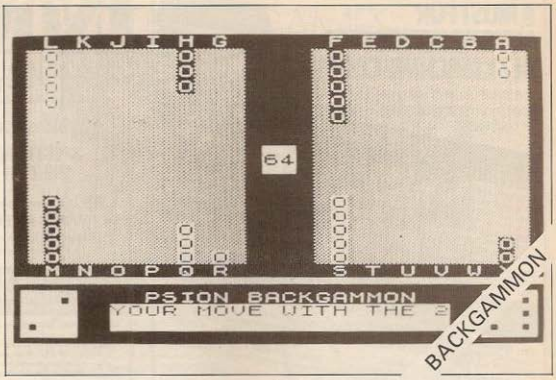
These junkies will pay an enormous price for your Boosterspice, a kind of inter-galactic heroin. But you have to be careful they do not mug you or your might pass out of the Meridien system, as I did, in a sordid back alley. Trader is great fun — do not be put off by the unnecessary packaging and silly booklet.

Traditional board games are also in evidence in ZX-81 software. Psion has both chess and backgammon tapes. Of the two programs backgammon is the more satisfying, since it suffers less from the graphics limitations of the ZX-81. By playing the computer you can teach yourself how to play the game. The display is clear and wrong moves are explained. Chess, on the other hand, is rather confusing; as the program notes suggest, it is a good idea to set up the game on a normal board. Another drawback is that moves are entered using algebraic notation — for example, E2-E4, but the board on the screen has no letters or numbers. If you are not familiar with the system it can take you some time to figure out what to enter. The computer's response is quick at levels 1 and 2, but on level 3 can take several minutes. At the two lower levels it plays a reasonable, though not very strong, game of computer chess.

Better value

Generally, those programs that have some practical application are better value than the games software and, to my mind, more interesting. Games, after all, are not the ZX-81's forte; most people buy the machine primarily as an introduction to computing rather than as a games machine.

In particular, probably more people have gained some familiarity with machine code on the ZX-81 than on any other home micro. Few Vic owners for example know where or how to insert machine-code routines; every dedicated



ZX-81 owner, by contrast, has learned the value of a hex loader or the significance of the figure 16514.

An assembler, of course, removes the hassle of hex loading. Bug-Byte's ZXAS allows you to enter standard Z-80 mnemonics in Rem statements and also accepts labels for jump and call instructions. It takes up 5K and will assemble code at any specified location.

Assemblers are indispensable to the serious machine-code programmer and Bug-Byte's is as effective as any other available. To go with it the well-equipped programmer also needs a machine-code monitor. Two on offer are from Picturesque and Crystal Computing. These are both well-written and useful programs although the Crystal Computing monitor is perhaps the superior version. In addition to providing a range of facilities for entering, displaying, moving and testing machine code, it also supplies a disassembler and the option for saving and loading blocks of memory in any part of RAM.

Picturesque's Screen Kit 1 contains a varied selection of machine-code routines which are embedded in Rem statements and can be used from Basic programs. These include routines for scrolling in any direction, saving and loading variables, and displaying the amount of memory left. Most of these routines have already been published in home computer magazines — or, at least, in *Your Computer* — but the collection could be recommended to newcomers.

Rather more useful is Bug-Byte's ZXTK toolkit. Again this is a suite of Rem-based routines but specifically intended as aids to program development. There are ten options which offer such features as renumbering and deleting of Basic program lines as well as facilities for moving and merging programs whenever you want.

Question of ease

There is not much to choose between the two programs. The Fast One leaves around 11,700 bytes free for file space and offers a greater range of features — including an option for finding the total and average of figures within selected records. Vu-File on the other hand has slightly less file space but is easier to use.

None of these facilities would be exceptional if they were present on a larger micro; but on the ZX-81 the speed and versatility of these programs is quite an achievement — given the limitations . . .

The final word in this review, sadly, must be a critical one. Many of the programs discussed were loaded only after repeated attempts. Some programs could not be reviewed because they obstinately and persistently refused to be loaded, even when tried on different recorders. One of these brutes was, unfortunately, Gauntlett — a game I would have liked to play as it features in *Your Computer's* Top Twenty. An honourable mention has to be made here of Psion, whose programs all loaded first time. While conceding that the ZX-81 is a sensitive beast which must be approached with caution, I do not see why manufacturers cannot take a little more care with their products and help the consumer to avoid the frustration and rage which are the result of faulty loading. ■

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SINCLAIR USER FEBRUARY 1983

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ZX COMPUTING FEB/MARCH 1983

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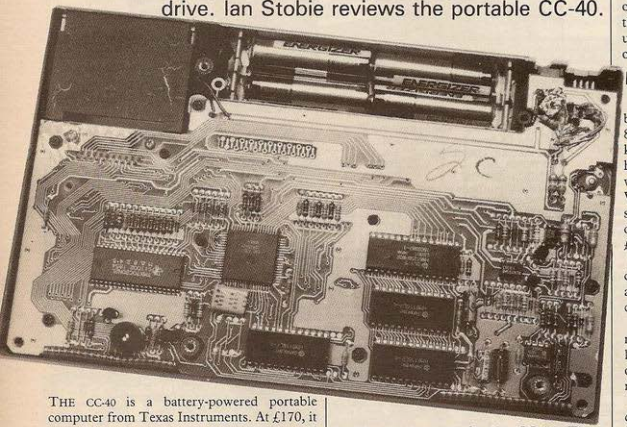
TEXAS

Compact Computer is the first of a new wave of micros from Texas which have been designed to use a range of miniaturised peripherals including a stringy-floppy tape drive. Ian Stobie reviews the portable CC-40.



THE CC-40 is a battery-powered portable computer from Texas Instruments. At £170, it is in the same price range as the Dragon and the 48K Spectrums and Orics — but that is its only similarity. The Compact Computer will never know the satisfaction of crushing a human at space invaders; it is a machine with a serious purpose.

Up until now Texas has taken care of the home market to its own satisfaction with the TI-99/4A. The Compact Computer 40 is an attempt to get into the booming portable market, currently dominated by names like Epson, NewBrain, Casio and Sharp.

The CC-40 weighs a little more than one pound and measures 9.25in. wide by 5.75in. high by 1in. thick — about the size of a big paperback. It can run for 200 hours on four AA size alkaline batteries and it has a built-in 31-character single-line liquid crystal display and good-quality calculator-style keys in a QWERTY layout.

Cartridge slot

Inside, the CC-40 is built around a Texas own-brand eight-bit CMOS chip, the 70C20. It comes with 34K of ROM containing a comprehensive Basic, and 6K of RAM extendable to 18K internally. A cover at the top edge of the machine to the right of the display pulls off to reveal a memory cartridge slot, and a further 16K of RAM can be fitted here, giving an absolute maximum of 34K RAM. Program cartridges also fit into this slot.

Texas expects great things for the new peripherals designed for the CC-40. These include a battery-powered four-colour printer/plotter of the Sharp type, a fast "Wafertape" continuous loop cassette drive like Sinclair's Microdrive, and an RS-232 interface unit for connecting up to big printers and, potentially, other computers.

A Modem and a black and white TV interface are also scheduled for release later in the year. The CC-40 system is clearly aimed at people using computers for their work; but this could include students of scientific or engineering subjects as well as professional users.

The whole machine is well made. For instance, along the bottom of the machine runs a recessed stand, which can be pulled down to tilt the keyboard to a nice angle for typing. There will be no need for entrepreneurs to offer adaptor feet at £4 a pair.

The casing itself is made from a silvery-grey plastic, except for the numeric keypad, a few of the other keys and the area around the screen, which are highlighted in a darker grey.

At the back of the machine is a slot for the optional AC adaptor which costs £14.95, and the Hex-bus connector, into which all the peripherals will fit.

There were no problems with the keyboard. The calculator-like keys feel comfortable and give tactile feedback. The layout is fairly close to the standard QWERTY pattern, but the Enter key, the Texas equivalent of Return, is rather annoyingly positioned where you might expect the right-hand shift key to be.

Given the size of the CC-40 the keys are obviously smaller than on a standard typewriter, but they are easy to use and larger than on the Sharp PC-1500 for instance, a machine with virtually the same price and an obvious competitor.

The CC-40 comes with a plastic keyboard overlay, which among other things has the principal Basic keywords on it. Basic keywords can either be typed in full in the normal way, or by using the function key then hitting the appropriate single key given on the overlay, the machine can be made to produce them Sinclair-style on the display. This is a useful time-saving feature, although the overlay itself might soon be lost.

Program scrolling

The display is a single line of 31 characters, but this can be used as a window on to an 80-character line. The arrow keys above the keypad can be used to scroll around horizontally within the line, or to step vertically within through a program listing. With a little practice the small display does not seem such a limitation, although for developing long programs the printer at £149.95, would be essential.

On the side of the machine to the left of the display is a knurled wheel. Turning this adjusts the display angle electronically, so you can aim it at yourself to get the best contrast.

The characters are formed on a five-by-eight matrix, and like all LCD displays are much less tiring to watch than a TV screen. The lack of colour confirms that this is a working machine, rather than an entertainment device.

On both sides of the actual text line in the display one finds indicators showing battery-low warnings, upper-case lock on, Function, and which units the trigonometric functions are currently returning value in.

The machine can be used as a calculator. It works exactly the same as Basic in immediate mode, but on the CC-40 it is not necessary to type Print before a calculation. You just key in 8*63 and then hit Enter, and it gives you the answer.

The up-arrow key, used with Control held down, functions as a playback key. Hitting it brings back the last line entered on to the display, where it can be edited, and the calculations redone. This saves time if you have entered a long complex calculation and want to try it out with a few different values.

For anything more complex there is Basic, and the CC-40 has a very full Basic. Again, it is practically oriented. There are no sound commands to support the small internal beeper, only the feeble Beep, but this is sufficient for attracting attention.

The numeric precision is good — 10 displayed significant digits — but the machine is not very fast. Battery-powered CMOS machines are inherently slow.

If your foreign languages need brushing up try,

```
Call Setlang 1
```

This puts out all the error messages in German — *Variable nicht definiert* — and that kind of thing. Other languages are available on ROM cartridges.

The Basic has all the usual commands of

CC-40 REVIEW

CONCLUSIONS

- The CC-40 is a well-made, battery-powered portable machine intended mainly for serious use. It will be good for field-work, travel, and as a sophisticated calculator replacement.
- The machine has no colour capability, and compared to a home-based micro limited maximum memory and a slow processor speed. It is not a games machine.
- The CC-40 is aimed at professional and technical users. It has a full and powerful Basic.
- Its main rivals will be the Sharp PC-1500, and perhaps even the luxury £700 Hewlett-Packard HP-75C.
- For serious users the range of mostly battery-powered peripherals will make the machine very attractive. The CC-40 really comes into its own as the central unit in a system.

Microsoft-style Basic. It includes If . . . Then . . . Else, On . . . Goto/Gosub/Error, Print Using to format output conveniently, and various file control commands for use with the Wafertape, like Open, Print#, Input#, and Verify. Three-dimensional arrays are allowed, and long variable names.

Strings can be up to 255 characters long. String handling works differently to most home micros. Instead of Left$, Mid$, Right$ the CC-40 has a Seg$ command for extracting substrings, and a Pos command to find them.

Another addition is the way subroutines are handled. Gosub is there and can be used in the normal way, but there are several more powerful commands allowing you to set up sub-programs. These are called with a Call statement and an optional set of parameters.

The 34K ROM contains a number of useful sub-programs. Call Debug gets you into a machine-code monitor, with all the usual Examine, Move, Copy and start Executing commands, plus the ability to set Breakpoints.

The CC-40 manual which describes all this is extremely good. It is a 300-page professional manual, not just a home micro manual.

Ready-written software will be available on cartridges and Wafertapes. Statistics, Finance, Maths and Electronics cartridges should be available immediately, with Perspective drawing, business graphics and a few others hot on their heels according to Texas. These all cost £59.95. Two games cartridges cost nearly £40, and the Assembler nearly £125, so software is not cheap.

The Wafertapes will be cheaper, just under £20. Again the announced titles look fairly professional — things like Elementary Dynamics, Pipe Design, Profitability Analysis. Texas hope to find third-party software suppliers to contribute additional titles. ■

Ghoulies and ghosties and long-leggety beasties and things that go bump in the night — smile please for the cameras of Captain Spectre and his Spectrum-powered Spook hunt. Meirion Jones joins the chase.

WHERE MICROS FEAR TO TREAD

BENEATH THE STREETS of Cambridge he waits for the call. A spear hangs from the ceiling, a sword from the wall. Any moment the red phone could ring and send Captain Spectre's Flying Squad and their electronic ghost trap out on the trail of another ghoul.

The scene sounds straight out of *The Avengers* but Captain Spectre's quarry is more elusive than any that Emma Peel or John Steed tracked down. His mission is to capture for the first time on film denizens of another world — spirits, poltergeists, ghosts. His only weapon is a 16K Spectrum linked to an array of sensors, lights, recorders and cameras.

Captain Spectre — or Tony Cornell as he would rather be known — is fully aware of the problems of capturing spirits on celluloid. As Treasurer of the Society for Psychical Research he has been able to leaf through the thousands of supposed ghost photographs sent to the SPR since it was set up a century ago to investigate paranormal phenomena. He believes that there is "not one photograph in the archives that we would today accept as genuine."

Traditional methods of investigating haunted houses or poltergeists, are unlikely to produce scientifically acceptable results. An observer who has been left for the night in some gothic manor is quite likely to be seeing things by the early hours of the morning whether they are there or not and if anything should happen the observers may not be able to turn on recorders or take a photograph in time.

An automatic observation station with cameras and recorders that can be instantly triggered by movement, temperature changes or sound and can be left to monitor a site for days at a time is far more likely to produce useful results. It is also less likely to be taken in by the many deliberate frauds and practical jokes which have often taken in investigators of the paranormal. Sherlock Holmes's creator Sir Arthur Conan Doyle who joined the SPR after pushing his all-seeing detective off the Reichenbach Falls remained convinced to the end of his life by a film purporting to show fairies dancing at the bottom of his garden. Last month — 60 years later — one of the fairies, Mrs Elsie Hill, finally admitted that it had all been a hoax.

Alan Cornell's first investigation of a poltergeist convinced him of the dangers of taking things at their face values. He had gone to an erie-looking Victorian house in North London where a mysterious crashing and banging noise in empty rooms had convinced a family that the house was haunted. The father, mother and three children had all moved out leaving only Grandad who refused to be scared off. On the evening that Cornell called in the old man was sitting in a corner by the fireplace. Cornell sat down and shortly afterwards he heard "thumps and bumps and crashes and bangs upstairs". A check of the upstairs room yielded no clues — there was nobody else in the house apart from the old man downstairs in his armchair. When the noise started again Cornell noticed out of the corner of his eye that Grandad was moving his shoulder.

"He had connected up two wooden balls and a heavy piece of lead under the floorboards upstairs to the old Victorian bell pull which had been used to call the servants". I asked him why he had pretended that the house was haunted. He said he had lived in the house for years and now he was old his family were planning to send him to an old people's home. It was a question of either they went or he went."

That was 25 years ago and Cornell has exposed many other frauds since — and not only in Britain. One of the strangest cases was a Dr Richards in America who claimed that inanimate objects in his fish tank were moving of their own volition and that he had film to prove it. At first glance his film was impressive but Cornell was able to duplicate the effect using standard animation techniques — shooting the film frame by frame and then moving the objects very slightly in between shots.

Dr Richards then claimed that if a question

Tony Cornell stands in his Cambridge basement surrounded by mementoes of previous ghost hunts. The strips of enlarged cine film behind him helped to expose Dr Richards and his allegedly haunted fish tank. Cornell's new Spectrum-based box of tricks should make it easier to expose fraud but also to obtain genuine evidence of paranormal events if they do occur.

in a self-addressed envelope was placed in the tank the spirits would answer it and return it through the U.S. mail. Using rubber gloves Cornell carefully prepared his question sheet and sent it to Dr Richards. Sure enough the answer came back through the post but when fingerprint powder was dusted over the sheet it revealed that Dr Richards' spirits had human finger and palm prints.

Although Cornell soon realised that automatic continuous surveillance equipment would make psychic research much easier, until recently the cost of such a system would have been prohibitive. Cheap home computers changed all that. The box of tricks at the heart of Cornell's monitoring system contains a 16K Spectrum, a Sinclair printer, a DCP Interspec, and a series of relays. An array of sensors can be connected up to the box. These include two infra-red beams and a doppler-shift ultrasonic alarm to detect movement, circuit breakers to detect small movements, and sensors which can be triggered by noise or sudden changes in temperature.

The Spectrum is programmed to monitor all these inputs and to respond. If a sensor is triggered the Spectrum turns on lights and runs a cine camera for 20 seconds. It also turns on a tape recorder for one minute and takes six still photographs with a motor-driven camera. The program also helps set up the equipment by checking through stage by stage with the operator that everything has been correctly connected. The Spectrum prints out a record of what responses were triggered and when. Once it has been set up the equipment can function for several days without attention.

The first test for the new box of tricks came this Christmas. A 200 year-old chest of drawers in an antiques warehouse had been at the centre of some strange happenings. For

(continued on page 53)

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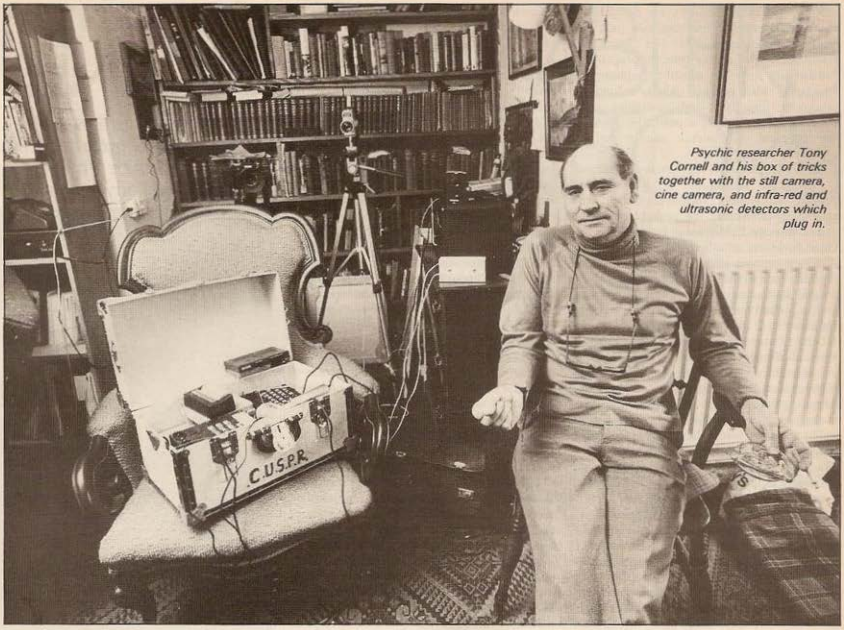

Psychic researcher Tony Cornell and his box of tricks together with the still camera, cine camera, and infra-red and ultrasonic detectors which plug in.

(continued from page 51)

weeks every morning when the staff came in the drawers would be hanging out at strange angles even though they had been pushed in when the staff had locked up the night before. Eventually Tony Cornell was called in. He and the Cambridge University Society for Psychical Research, CUSPR, staked out the storeroom the chest was in with their box of tricks. The response was triggered eight times but the drawers had not moved and there was nothing unusual on the film. The equipment may have been triggered by a spike in the mains current so a mains smoother has subsequently been fitted. Since then there have been no further strange happenings with the chest which now sits uncomfortably in Tony Cornell's basement with two tribal sculptures eyeing it suspiciously from across the room.

Cornell is cynical about haunted houses — he believes that ghosts may be in the eyes of the beholders once they have been told that a particular place has a spooky reputation. Once he and several members of the SPR were invited to the Ferryboat Inn in Huntingdon to witness an apparition by the White Lady who was supposed to appear every March 17. "The landlord gave us dinner, there were hundreds of sightseers, Americans everything. No-one had ever seen the White Lady — it was terrible. Some months later I saw it in a Sunday magazine described as 'The fifth most haunted house in Britain'."

Because of his own experience he is less cynical about poltergeists. At Hanneth Hall in Wisbech, Cambridgeshire, he was among a team of investigators who tore the place apart looking for any normal explanation of the bumps and thumps and objects flying around which they experienced there.

At one time it was thought that such effects might be caused by vibration perhaps from underground streams or seismic activity. Cornell's own experiments convinced him that was not the case. He obtained permission to subject four cottages which were scheduled for demolition to intense vibration. Although the tests were continued to the point when the cottages were about to collapse they were unable to duplicate the effects attributed to poltergeists.

Spectrum telepathy

Richard Loosemoore, who built Cornell's box of tricks for just over £200 — the cameras and sensors are borrowed as and when necessary — is hoping to use a 48K Spectrum for more psychic research. He is conducting research into Artificial Intelligence — in particular cognitive psychology. But his own interest is telepathy. He believes that "there is no question about the proof of telepathy — it is just a question of what the mechanism is."

In Loosemoore's experiments two volunteers sit in separate rooms and one attempts to transmit his or her emotional state — agitation, relaxation or anxiety — to the other by telepathy. Using the same principle as a lie detector the observers measure the Galvanic Skin Response — changes in skin conductivity — of both volunteers. If they really are able to transmit emotions by telepathy then the observers should be able to detect simultaneous changes in the GSRs of both volunteers.

In the past Loosemoore has had to borrow expensive purpose-built machines when he can to process and evaluate the data. The CUSPR has now given him £300 which he hopes will allow him to build a new system around a 48K Spectrum which will make it possible to carry out far more tests.

Tony Cornell has found the recent publicity for his investigations of the paranormal to be a mixed blessing. He never knows who is going to be on the other end of the line when the red phone goes. "I could be called out by two raving nutters — there is a lot of cranky stuff in this field". The shelves of Cornell's basement contain everything from Nostradamus's prophesies of doom and destruction to Eric von Daniken's tales of prehistoric spacemen.

Cornell suspects that "some as yet little known human faculty" may be responsible for psychic phenomena. His failure to catch a spirit red-handed opening the 200-year-old chest of drawers has not led him to believe that the spirits have something against being photographed. "After all" he says sounding more like a social worker than a psychic researcher "they are only doing it to draw attention to themselves." ■

SPECT

To turn those dreams of machine-code programs into living facts, take Phil Holliday's advice on assemblers and monit

ASSEMBLERS AND monitors are designed to make the process of machine-code programming as simple as possible. The input to an assembler — the source code or program — consists of lines of assembly-language instructions, with optional labels, comments, assembler directives and assembler commands. Labels identify a particular point in the program. Comments enable you to document your program.

Assembler directives are pseudo-instructions — not Z-80 mnemonics — which either provide parameters for operation of the assembler, or instruct the assembler to store values directly in memory. Commonly provided directives include Org — short for origin — which supplies the starting address of the machine code to the assembler and Equ which assigns a value to a label. DefB, DefW and DefM insert a byte, word or string respectively at the current address.

Unlike assembler directives, commands have no effect on the object code produced by the assembler but instruct the assembler to perform certain operations, such as to produce a heading in the listing, or change the address in the listing from hexadecimal to decimal.

The output from the assembler is the hexadecimal machine code — object code — which is loaded directly into memory, and optionally a listing which has the addresses and op-codes added to the source file.

The assemblers reviewed used one of two methods to enter the source code. Either the source code is entered in Rem statements in Basic, or an integral editor is supplied as part of the assembler package. Normally these editors use line numbers, just as in Basic, but with an auto-line number, renumber and block-delete facility. Since most of the time spent sitting at the keyboard is actually spent using the editor, either just entering source code, or else modifying it in the debugging phase, it is most important to have an editor which is quick and easy to work.

Finally having entered and assembled a source file, it must be run and debugged. A monitor is required for this. Some assemblers do contain a simple set of monitor commands but, in general, a more comprehensive monitor is required. In particular, commands are required which allow registers and memory to be inspected and modified, and to run the program from a given address with break-points set to terminate the run at a given address or addresses. Other necessary facilities are the ability to relocate the assembled object code — it may actually need to be run in the area occupied by the assembler for instance — and a disassembler would be required if the assembler does not produce a listing of the assembled program.

List of suppliers	Price
ACS Software, 7, Lidgett Crescent, Leeds LS8 1HN.	
Ultraviolet assembler	£7.50
Infrared disassembler	£6.75
Artic Computing, 396, James Reckitt Avenue, Hull, North Humberside.	
48K Spectrum Assembler	£9.95
Spec Bug monitor	£6.95
Bug-Byte, 100 The Albany, Old Hall Street, Liverpool L3 3AB.	
Aspect assembler	£9
CP Software, 17 Orchard Lane, Prestwood, Buckinghamshire HP16 0NN	
Spectrum assembler	£4.95
Crystal Computing, 2 Ashton Way, East Herrington, Sunderland SR3 3RX.	
Zeus assembler	£8.95
Monitor and disassembler	£8.95
Hisoft, 60 Hallam Moor, Liden, Swindon SN3 6LS.	
DevPac	£12
Picturesque, 6 Corkscrew Hill, West Wickham, Kent BR4 9BB.	
Spectrum editor-assembler	£8.50
Spectrum monitor	£7.50

In ACS Software's Ultraviolet Assembler, the Basic editor is used to enter source code into Rem statements. A dummy Rem statement, long enough to hold the assembled code, must be created as the first line of the program. The source code is then assembled by the Ultraviolet assembler and a listing is sent to the screen, with different classes of op-code being printed using different paper colours. The listing can optionally be sent to the ZX Printer. All numbers must be entered in decimal, and multiple statements can be entered in one Rem line. The Infrared disassembler is also available from ACS and produces a similar colourful output to the Ultraviolet assembler.

The Ultraviolet Assembler — from Artic Computing contains a built-in monitor and only runs on the 48K Spectrum. The source code is automatically stored in a Rem statement at line 2, and the object code is put into a Rem statement in line 1. The editor is fairly comprehensive. It does not use line numbers, like all the other products reviewed here, but has a screen editor mode in which the cursor can be moved up and down to point at lines. Lines can be inserted or deleted at the cursor position. A line-editor mode is also available allowing text to be modified.

The assembly is initiated from the built-in monitor, which also allows the assembled program to be run. Most of the normal monitor functions are included, allowing memory and registers to be inspected and modified and blocks of memory to be moved, but it does not have a breakpoint facility which is essential for debugging. Also it has no disassembler, which is vital since the assembler does not produce a listing of the assembled code.

One very useful feature of this product is a memory status report at the bottom of the screen showing how much memory is occupied by the source, object, labels and Basic program and how much is still free. The documentation is good, providing clear instructions and hints and examples to the user.

The Aspect 4.2 Editor-Assembler by Bug-Byte proved to be a very disappointing program. The editor is most unfriendly. It has an invisible cursor, which makes entering and modifying the source code very difficult indeed. Text cannot be inserted or deleted without first deleting all characters from the end of the line back to the required point. The labels can be of any length but they are cut to five characters length in the listing. The symbol table space is fixed at approximately 450 bytes, which may be very limiting in some applications. There is no way of outputting the listing or symbol table to the printer, which makes debugging very difficult. The documentation is barely adequate.

The assembler from CP Software is very limited. It is written in Basic and assembles the code at a painfully slow rate. The source code is entered into Rem statements. Labels are limited to three characters in length, and the only assembler directive provided is DefB.

The Zeus assembler from Crystal Computing is a well thought-out program. It has a true screen editor. Text may be displayed and modified by moving the cursor to the appropriate place in a line on the screen. It also has a good auto-line number, renumber and block-delete facility. This editor was easy and pleasant to use. The assembler does not produce a listing, but the source code and symbol table can be sent to the printer or screen. A built-in monitor allows the assembled object code to be run, and has other useful features.

However, a separate and more comprehen-

RUM ASSEMBLERS AND MONITORS

rs.

sive monitor is available from Crystal Computing which allows breakpoints to be set and the program to be run and disassembled. The documentation supplied is very good. The manual starts with an example of a machine-code program and the user is taken step by step through the process of editing and assembling it.

The most comprehensive product reviewed was DevPac by Hisoft. The assembler-editor — Gens — and monitor — Mons — are two separate programs but are sold as one product — DevPac. The editor is an extremely comprehensive line editor. It takes a little time to learn to drive it but it is well worth the effort. It includes auto-line number, renumber and block delete.

The line-editing commands available are too numerous to list here. Some examples are commands to delete or insert characters, delete all characters from the cursor to the end of the line, reload the edit buffer from the text and many others.

The assembler is very fast and the only one reviewed with the powerful conditional assembly feature If-Then-Else. It also allows expressions of decimal, hex, binary, character constants and labels with operators of addition, subtraction, integer multiplication and division, logical And, Or and Xor, and mod operators. There are many assembler commands available which can be inserted into the source code. It is possible to enable and disable the listing and printer, and to list the location counter in hexadecimal or decimal with the appropriate commands. Options can also be selected at assembly time, enabling the object code and listing to be turned off, and to direct the listing to the printer.

The Mons monitor provides all the usual commands one would expect. Registers and memory can be inspected and modified, and memory can be moved. It also contains a disassembler which inserts labels into the disassembled listing. The object code can be executed, and break-points set, but what sets this monitor apart from all the rest is that it can be single-stepped through the program, with a disassembly of the instruction executed displayed. Commands are available which allow single-stepping to continue after a jump or call. This, like the assembler, is a most comprehensive tool. The DevPac will appeal to the true machine-code freak who wants to write a lot of software. The documentation is first class.

The first thing that you notice about this neat product, the Editor Assembler by Picturesque, is that instead of the normal 32 columns on the screen it gives you 40. This is a very real advantage for listing the assembled source program. The whole package is very friendly and easy to use. The line editor is quick and simple to use.

The line is automatically set up with tabs at the required places. This is the fastest editor to use of all those reviewed. The only criticism is that characters cannot be inserted within a line without first deleting characters from the end of the line back to the required point.

The assembler is fast and the listing produced is very easy to read because of the 40-column line. The listing can be turned off or sent to the printer at assembly time. An extremely useful function, especially for those with 16K machines, is that once a module of source code has been assembled it can be cleared from the text buffer whilst retaining the symbol table. Thus a large program can be split into smaller modules and still be assembled, even with label references which cross module boundaries. To help this there is an assembler directive, DefL, available which allows a label value to be redefined within a program. Source and object code can be saved to tape from within the assembler.

A monitor program, which has all the normal monitor commands and includes a disassembler, is also available and documentation for both products is very good.

The Picturesque and Crystal Computing products can be highly recommended for those who are just about to start programming in machine code, whilst for those who are already familiar with the techniques then the DevPac is most highly recommended. ■

Table 1.

Company	ACS	Artic	Bug-Byte	CP	Crystal	Hisoft	Picturesque
Product name	**Ultra-violet**	**Assembler**	**Aspect**	**Assembler**	**Zeus**	**Gens**	**Assembler**
16K	Yes	No	Yes	Yes	No	Yes	Yes
48K	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Label size	Any	Any	Any	3	14	6	5
Hex	No	Yes	Yes	Yes	Yes	Yes	Yes
Decimal	Yes	Yes	Yes	No	Yes	Yes	Yes
ORG	Yes	Yes	Yes	No	Yes	Yes	Yes
EQU	Yes	Yes	Yes	No	Yes	Yes	Yes
DEFB	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DEFW	Yes	Yes	Yes	No	Yes	Yes	Yes
DEFM	Yes	Yes	Use DB	No	Yes	Yes	Yes
DEFS	No	No	Yes	No	No	Yes	Yes
ENT	No	No	No	No	Yes	Yes	No
Cond assembly	No	No	No	No	No	Yes	No
Opt assembly	No	No	No	No	No	Yes	No
Save to tape	Basic	Basic	Basic	Basic	Basic	Yes	Yes
Error reports	5	6	4	5	10	17	8
Output to printer	Yes	Yes	No	Yes	Yes	Yes	Yes
Listing	Yes	No	Yes		No	Yes	Yes
Editor	Basic	Screen	Line	Basic	Screen	Line	Line
Documentation	Sparse	Good	Poor	Poor	Good	Excellent	Excellent
Monitor included	No	Yes	No	No	Yes	No	No
Monitor separate	No	No	No	No	Yes	Yes	Yes

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	32K RAM Kit (Issue 2 Spectrum)	£32.50	
	16K RAM for VIC 20	£47.95	
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```
10 REM*************************
20 REM******BATTLE TANKS*******
30 REM**********BY**************
40 REM****V.COCKETT ESQ.******
50 REM*************************
60 PCLS:CLS0:DIMA(7,4)
70 DATA32,165,173,154,160,33,173,168,171,153,1,160,172,174,147,-31,150,174,162,1
67,-32,149,160,170,171,-33,173,153,171,161,-1,167,156,160,163,31,164,174,150,167
80 FORT=0TO7:FORT1=0TO4:READA(T,T1):NEXT:NEXT
90 GOSUB610
100 GOSUB370
110 L=&H4E1:R=&H4F7:M=32:M2=32:Y=1
120 R1=165:R2=173:R3=154:R4=160:L1=R1:L2=R2:L3=R3:L4=R4
130 PRINT@33,HL;:PRINT@60,HR;
140 IFHL=10 ORHR=10 THEN1080
150 LR=JOYSTK(0):LM=JOYSTK(1):RR=JOYSTK(2):RM=JOYSTK(3)
160 PLAY"V3T255O3CFC
170 IFLMK5 THENX1=L:C=128:XL=1:GOSUB600
180 IFRMK5 THEN X1=R:C=128:XR=1:GOSUB600
190 IFPEEK(L-M)>239 ORPEEK(L-1-M)>239 ORPEEK(L-31-(2*M))>239 ORPEEK(L-32-(2*M))>
239 THEN210
200 IFXL=1 THENL=(L-M)-((L&H400)*512)+((L>&H615)*512):GOTO220
210 IFG=3 THENX=L:HL=HL-1:GOSUB1030:C=128:X1=R:GOSUB600:GOSUB1140:GOTO950
220 GOSUB350
230 IFPEEK(R-M2)>239 ORPEEK(R-1-M2)>239 ORPEEK(R-31-(2*M2))>239 ORPEEK(R-32-(2*M
2))>239 THEN250
240 IFXR=1 THENR=(R-M2)-((R<&H400)*512)+((R)&H615)*512):GOTO260
250 IFG=3 THENX=R:HR=HR-1:GOSUB1030:C=128:X1=L:GOSUB600:GOSUB1140:GOTO950
260 GOSUB360
270 P=PEEK(&HFF00):IFP=125 ORP=253 THENX=(R-(2*M2)):R5=X:F=M2:GOSUB420
280 IFP=126 ORP=254 THENX=(L-(2*M)):L5=X:F=M:GOSUB420
290 IFY=0 THEN110
300 M1=M:IFM=1 ORM=-32 THENM1=-M1
310 M3=M2:IFM2=1 ORM2=-32 THENM3=-M3
320 IFLR<5 ORLR>59 THEN AR=(AR+(1*SGN(32-LR)))+((AR=0 ANDLR>59)*-8)+((AR=7 ANDLR
<5)*8):M=A(AR,0):L1=A(AR,1):L2=A(AR,2):L3=A(AR,3):L4=A(AR,4):GOSUB350
330 IFRR<5 OR RR>59 THEN BR=(BR+(1*SGN(32-RR)))+((BR=0 ANDRR>59)*-8)+((BR=7 ANDR
R<5)*8):M2=A(BR,0):R1=A(BR,1):R2=A(BR,2):R3=A(BR,3):R4=A(BR,4):GOSUB360
335 XL=0:XR=0
340 GOTO150
350 POKEL,L1:POKEL+1,L2:POKEL-31,L3:POKEL-32,L4:RETURN
360 POKER,R1:POKER+1,R2:POKER-31,R3:POKER-32,R4:RETURN
370 FORT=0TO4:POKE&H44D+T,255:POKE&H5AD+T,255:NEXT
380 FORT=0TO192 STEP32:POKE&H4B4+T,255:POKE&H49B+T,255:NEXT
390 FORT=0TO64 STEP32:POKE&H4CA+T,255:POKE&H4D5+T,255:NEXT
400 POKE&H46D,255:POKE&H471,255:POKE&H483,255:POKE&H49C,255:POKE&H4EF,255:POKE&H
543,255:POKE&H55C,255:POKE&H5BD,255:POKE&H591,255
410 RETURN
420 FORT2=1TO12:Y$=STR$(13-T2):PLAY"V2003":PLAY+Y$
430 IFPEEK(X)>148 AND PEEK(X)<175 THEN510
440 IFPEEK(X)>239 THEN POKEX+F,128:S=225:FORT=1TO4:S=390-S:SOUNDS,1:NEXT:RETURN
450 OF=X
460 POKEX,196
470 X=X-((X<&H420)*512)+((X>&H600)*480)-F
480 POKEOF,128
490 NEXT
500 POKEX+F,128:RETURN
510 R5=R5-(T2*F)+F:L5=L5-(T2*F)+F
520 POKEX+F,128:FORT=1TO6:FORT1=1TO3
530 C=(16*T1)+175:C$=STR$(T1*4):PLAY"V31":PLAYC$
540 IFX=R5 THEN X1=L:GOSUB600:NEXTT1:E=0:NEXT:HR=HR+1
550 IFX=L5 THEN X1=R:GOSUB600:NEXTT1:E=0:NEXTT:HL=HL+1
560 C=128:GOSUB600
570 IFX1=L THENX1=R:C=128:GOSUB600
580 IFX=L5 THEN X1=L:C=128:GOSUB600
590 Y=0:RETURN
600 POKEX1,C:POKEX1+1,C:POKEX1-31,C:POKEX1-32,C:RETURN
610 CLS:PRINT"*****************************";
620 PRINT"********** BATTLE TANKS *********";
630 PRINT"*****************************"
640 PRINT@160," USING YOUR JOYSTICK YOU HAVE "," TO DESTROY YOUR FRIENDS TANK","
 BEFORE HE GETS YOU.BE CAREFUL"," HE MAYBE HIDING AROUND THE "," CORNER......
650 PRINT@352," BE SURE TO CHOOSE YOUR FRIENDS"," WITH CARE!!!
660 PRINT@454,"PRESS SPACE TO PLAY
670 IFINKEY$<>" " THEN670
680 CLS
690 PRINT@65,"PLEASE SELECT GAME:-
700 PRINT@168,"1----BATTLE FIELD
710 PRINT@205,"(IT'S A SHOOT OUT)
720 PRINT@264,"2----HIDE & SEEK
730 PRINT@301,"(MIND THE BARRIERS)
740 PRINT@360,"3----MINE FIELD
750 PRINT@397,"(BEWARE THE MINES)
760 PRINT@456,"4----FORCE FIELD
770 PRINT@493,"(HIDDEN BARRIERS)
780 G$=INKEY$:IFG$=""THEN780
790 IFVAL(G$)<1 ORVAL(G$)>4 THEN780
800 G=VAL(G$):CLS:GOTOB30
810 CLS:GOTOB30
820 PRINT@34,"NOW YOU KNOW WHO IS'NT YOUR "," FRIEND...WHY NOT TRY AND ","GET YO
UR OWN BACK!!!!
830 PRINT@165,"PLEASE SELECT:-
840 PRINT@232,"A----AMATEUR
850 PRINT@296,"P----PROFESSIONAL
860 PRINT@360,"E----TO END
870 A$=INKEY$:IFA$=""THEN870
880 IFA$="A" THENPOKE65494,0:GOTO920
890 IFA$="P" THENPOKE65495,0:GOTO920
900 IFA$="E" THENPOKE65494,0:FORT=0TOB:CLST:SOUND(T+1)*25,1:FORT1=1TO30:NEXTT1:N
EXT:SOUND25,4:END
910 GOTO870
920 CLS0
930 HL=0:HR=0
940 IFG=2 THEN100
950 IFG=3 THENGOSUB1000:GOTO110
960 IFG=4 THENGOSUB1010
```

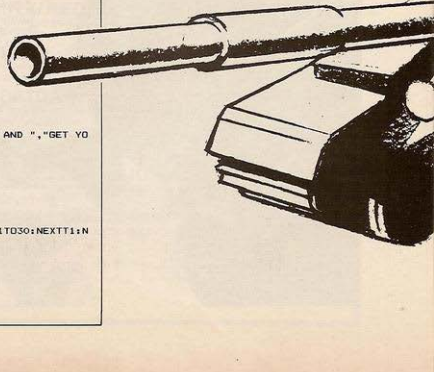
BAT

BATTLE TANKS is a Dragon 32 game for two players using the joystick controls. There is a choice of four options. First is an enclosed screen where each player blasts away at the other tank without any restrictions. However, the tanks have limited shell ranges. In the second version the players have barriers to hide behind to escape from their enemy. However, each can drive or fire off the edges of the picture, returning at the opposite side to catch the enemy unawares.

Minefields, the third option, is displayed on an apparently clear screen. Hidden within the picture are three randomly-positioned mines. If you ride over these mines you are blown up and lose a penalty point. The hidden mines are achieved by Poking on to the picture the value 240. This corresponds to the black in the orange colour set as opposed to the black value 128 normally displayed by the Dragon.

The final option, Force Field, employs the use of the value 240 and Pokes this on to the screen to form invisible walls to negotiate. The object of all the games is to score 10 hits to win. With the hidden mines and walls the player can fire their guns to determine the position of the obstructions as the shell automatically stops when they are detected.

To convert the program from joystick to keyboard operation add in the lines shown. The left-hand tank uses key 2 to go forward, Q-left, W-right, A-fire. The right-hand tank uses the minus sign to go forward, @ to go left, a left-pointing arrow to go right, and Enter to fire.



TLE TANKS

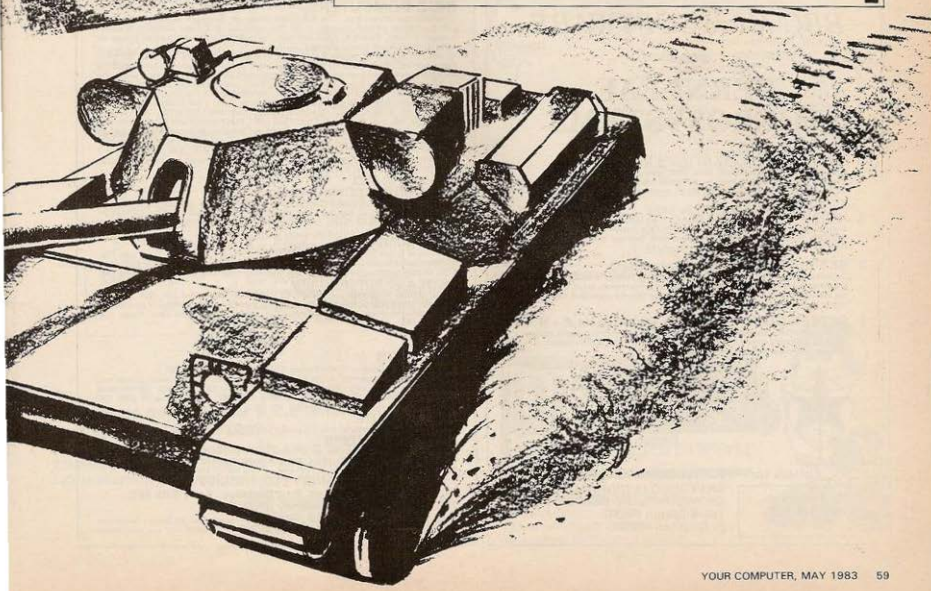
DRAGON

As the steel tide of war rips across the disputed zone, you get your free invitation to take part in the holocaust, courtesy of Vincent Crockett.
Can you and the crew of your main battle tank survive?

```
970 FORT=0TO31:POKE&H400+T,255:POKE&H5E0+T,255:NEXT
980 FORT=1TO14:POKE&H400+(T*32),255:POKE&H41F+(T*32),255:NEXT
990 GOTO110
1000 CLS0:FORT=0TO2:POKE&H421+RND(360),240:NEXT:RETURN
1010 FORT=0TO4:POKE&H487+T,240:POKE&H574+T,240:POKE&H50B+(T*32),240:POKE&H45A+(T
*32),240:NEXT
1020 RETURN
1030 A=42:SOUND4,1:GOSUB1050:A=159:GOSUB1050:A=102:SOUND15,1:GOSUB1050:A=175:SOU
ND50,1:GOSUB1050
1040 A=87:SOUND100,1:GOSUB1050:A=255:SOUND4,1:GOSUB1050:A=128:SOUND35,1:GOSUB105
0
1050 POKEX,A:POKEX+1,A:POKEX-1,A:POKEX+32,A:POKEX-32,A
1060 POKEX+2,A:POKEX-2,A:POKEX+64,A:POKEX-64,A
1070 POKEX+31,A:POKEX+33,A:POKEX-33,A:POKEX-31,A:RETURN
1080 PRINT@449,"AGAIN (Y/N) OR CHANGE GAME (C)";
1090 A$=INKEY$:IFA$=""  THEN1090
1100 IFA$="Y" THENFORT=1473 TO1502:POKET,128:NEXT:GOTO920
1110 IFA$="N" THENA$="E":GOTO900
1120 IFA$="C" THEN680
1130 GOTO1090
1140 PRINT@449,"LOST ONE PENALTY POINT";
1150 FORT=1TO500:NEXT
1160 FORT=1473TO1495:POKET,128:NEXT:RETURN
```

Modifications for joystick control.

```
150 REM
170 IFPEEK(340)=254 THENX1=L:C=128:XL=1:GOSUB600
180 IFPEEK(343)=253 THEN X1=R:C=128:XR=1:GOSUB600
230 IFPEEK(R-M2)>239 ORPEEK(R-1-M2)>239 ORPEEK(R-31-(2*M2))>239 ORPEEK(R-32-(2*M
2))>239 THEN250
270 IFPEEK(338)=191 THENX=(R-(2*M2)):R5=X:F=M2:GOSUB420
280 IFPEEK(339)=251 THENX=(L-(2*M)):L5=X:F=M:GOSUB420
320 IFPEEK(339)=239 ORPEEK(345)=239 THEN AR=(AR+((PEEK(339)=239))*-1)+(PEEK(345)
=239)*((AR=0 ANDPEEK(345)=239)*-8)*((AR=7 ANDPEEK(339)=239)*8):M=A(AR,0):L1=A(AR
,1):L2=A(AR,2):L3=A(AR,3):L4=A(AR,4):GOSUB350
330 IFPEEK(338)=251 ORPEEK(343)=223 THENBR=(BR+((PEEK(338)=251)*-1)+(PEEK(343)=2
23))*((BR=0 ANDPEEK(343)=223)*-8)*((BR=7 ANDPEEK(338)=251)*8):M2=A(BR,0):R1=A(BR
,1):R2=A(BR,2):R3=A(BR,3):R4=A(BR,4):GOSUB360
```



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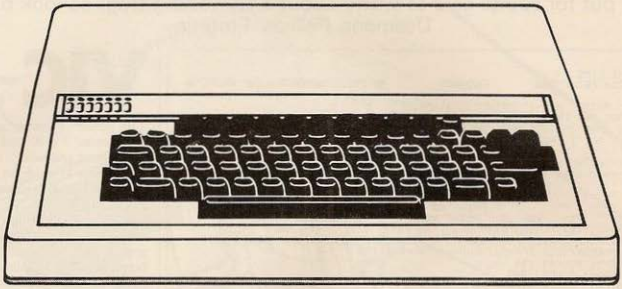

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FROG ON T

The truckers on this four-lane freeway are too busy chomping chocolate bars and watching out for sports cars to worry about a jaywalking frog: so look both ways in Desmond Phillips' Frogrun.

```
1 REM FROGRUN
2 REM (C) D.PHILLIPS
10 POKE36879,254:PRINT"[illegible]        FROGRUN        [illegible]":PRINT"[illegible]CONTROLS[illegible]":PRINT"[illegible]
U"
20 PRINT"   I":PRINT" H-+-J":PRINT"   |":PRINT"   N"
30 PRINT"[illegible] DODGE THE TRUCKS AND  CATCH THE LOGS!"
40 PRINT"[illegible] YOU HAVE 3 LIVES AND  30 SECONDS TO GUIDE   YOUR FROG HOME"
50 PRINT"[illegible] ONCE ALL 3 FROGS ARE  HOME YOUR TIME LIMIT  WILL DECREASE[illegible]":GOSUB650
CLR
60 SC=0:L=3:S1=36876:F1=32:F2=32:F3=32:T%=1800:FT=0
70 OP=32:OC=1:V=10:X=15:TI$="000000":POKE36878,15
80 PRINT"[illegible]":PRINT"[illegible]":PRINT"[illegible]"
90 PRINT"[illegible]":PRINT"[illegible]"
100 PRINT"[illegible]":PRINT"[illegible]"
110 PRINT"[illegible]":PRINT"[illegible]"
120 PRINT"[illegible]"
130 POKE7685,F1:POKE7694,F2:POKE7698,F3:POKE38405,5:POKE38414,5:POKE38418,5
140 DV=0:DX=0:A=PEEK(203):IFA=51THENDV=-1:PUKES1,180
150 IFA=28THENDV=1:POKES1,190
160 IFA=43THENDX=-1:POKES1,200
170 IFA=20THENDX=1:POKES1,210
180 POKES1,0
190 IFX+DX<10RX+DX>20THEN420
200 IFV+DV>10THEN300
210 P=PEEK(7680+V+DX+44*(V+DV))
220 IFV>1ANDV<6ANDP=32THEN420
230 IFV>6ANDP<>32ANDP<>35THEN420
240 IFV+DV=0ANDP<>32THEN420
250 IFV+DV=0ANDP=32THEN520
260 IFDV=0ANDDX=0THEN290
270 POKE7680+X+44*V,OP:POKE38400+X+44*V,OC
280 OP=PEEK(7680+X+DX+44*(V+DV)):OC=PEEK(38400+X+DX+44*(V+DV)):SC=SC+10
290 X=X+DX:V=V+DV:POKE7680+X+44*V,35:POKE38400+X+44*V,5
300 IFV=10RV=3THENX=X-1:
310 IFV=20RV=4THENX=X+1
320 IFV>5ANDV<10THENPOKE7680+X+44*V,32
330 POKE2,30:POKE1,44:SYS820:POKE1,88:SYS866:POKE1,132:SYS820:POKE1,176:SYS866
340 POKE2,31:POKE1,8:SYS820:POKE1,52:SYS866:POKE1,96:SYS820:POKE1,140:SYS866
350 P=PEEK(7680+X+44*V):IFP<>32ANDP<>35THEN420
360 IFV>5ANDV<10THENPOKE7680+X+44*V,35:POKE38400+X+44*V,5
370 IFSC>HITHENHI=SC
380 PRINT"T:"TI$"  L:"L
390 PRINT"S:"SC"[illegible]":PRINT"[illegible]HI:"HI"[illegible]"
400 IFTI>T%THEN420
410 GOTO140
420 POKE7680+X+44*V,OP:POKE38400+X+44*V,OC
430 POKE7680+DX+X+44*(V+DV),35:POKE38400+X+DX+44*(V+DV),2:
440 FORT=15TO0STEP-.3:POKES1-1,128+2*T:POKE36878,T:NEXT:POKE36875,0
450 L=L-1:IFL=0THEN470
460 FORT=1TO1000:NEXT:GOTO70
470 PRINT"[illegible] ANOTHER GAME [Y/N]?"
480 POKE198,0
490 GETA$:IFA$="Y"THEN60
500 IFA$<>"N"THEN490
510 POKE2,0:SYS2
520 POKE7680+X+44*V,OP:POKE38400+X+44*V,OC
530 POKE7680+X+DX+44*(V+DV),35:POKE38400+X+DX+44*(V+DV),5
540 FORT=1TO30:FORG=200TO210:POKES1,G+T:NEXT:NEXT:POKES1,0
550 FORT=1TO1000:NEXT:SC=SC+500
560 IFX=5THENF1=35
570 IFX=14THENF2=35
580 IFX=18THENF3=35
590 FT=FT+1:IFFT=3THENFT=0:F1=32:F2=32:F3=32:T%=T%-300:SC=SC+1000
600 GOTO70
610 DATA 165,1,133,251,165,2,24,105,120,133,252,162,20,160,0,177,1,72,200,177,1
36,145
620 DATA 1,200,104,145,1,136,177,251,72,200,177,251,136,145,251,104,200,145,251
202,16
630 DATA 226,96,165,1,133,251,165,2,24,105,120,133,252,162,20,160,20,177,1,72,2
00,177,1
640 DATA 136,145,1,200,104,145,1,136,177,251,72,200,177,251,136,145,251,104,200
,145,251
650 DATA136,136,202,16,224,96:FORT=820TO913:READK:POKET,K:X=X+K:NEXT:IFX<>12468
THENSTOP
660 DATA 153,153,126,24,219,189,153,129,7,63,127,127,127,127,63,7,0,255,255,255
,255
670 DATA 255,255,0,112,254,241,241,241,241,254,112,255,255,255,255,255,255,255,
255
680 DATA 7,63,71,71,71,71,63,7,112,254,255,255,255,255,254,112,7
690 POKE56,28:POKE52,28:POKE51,0:POKE55,0:FORT=0TO511:POKE7168+T,PEEK(32768+T):
NEXT
700 FORG=7448TO7503:READK:POKEG,K:NEXT:POKE36869,255:RETURN
```

VIC-20

THE GAME Frogrun is designed for the unexpanded Vic-20 and uses machine code and defined graphics.

You have to guide an intrepid frog across four lanes of busy highway and safely on to the pavement. He then has to hop between the logs and make it to his home in a gap in the bank. There is a 30-second time limit — this goes down by five when three frogs have made home. You are not allowed near the edge of the screen or on the river bank.

The contest finishes when three frogs have been flattened. A main loop is incorporated and various subroutines. The scrolling is done by two machine-code routines in the cassette buffer at locations 820 and 866. These scroll right and left for one line whose starting address is at location 1 and 2. Unfortunately, the machine code and defined graphics take up a lot of memory as they have to be loaded from Basic.

10-50	Title screen
60-70	Initialise variables
80-130	Print game screen
140-180	Player input
190-260	Check move
270-290	Move frog
300-360	Scroll logs and trucks
370-410	Print Time, Score
420-510	Splat!
520-600	Frog Home!
600-650	Machine-code data
650-700	Defined graphics.

To stop painful crashes, there is an error trap in 650 that checks the sum total of the machine code data and Stops it if there is a discrepancy. The controls U, H, J and N are read by Peeking location 203 and can be changed be reference to the table on page 179 of the Reference Guide. My own personal high score is 13,410.

HE HIGHWAY

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Interfaces for most popular home computers which do not have RS232 ports will be available shortly. An interface for the ZX81 that includes a complete Machine Code Communications Program is available. Order As LK08J (ZX81 Modem Interface Kit). Price £24.95.
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SAVED!

Andy Scott helps you attain the goal of better saving on the ZX-81 by providing a much-needed Tape Verify routine — amount of memory is not important.

AN UNFORTUNATE shortcoming of the ZX-81 is the absence of a tape verify. Considering the poor quality of many tape recorders that get used with ZX-81s, and the widespread use of cassettes that have not been certified for data storage, there is a fair probability that, once in a while, a program will not be saved correctly.

Nothing is more frustrating than spending hours typing in a program, saving it and reloading it at a later date only to find it cannot be loaded due to a saving error. A Verify routine which checks the saved program against the one in memory would be a great asset.

This program is suitable for any ZX-81 — amount of memory is not important. The Verification program is in machine code and sits above RAMtop, thus being protected against New and Load. The program occupies 116 bytes, hence users of small memory ZX-81s should bear this in mind. If users already have machine-code programs above RAMtop, these will not be destroyed or relocated: the Verify program will sit between these and RAMtop.

Program 1 resets RAMtop to accommodate the routine. It looks at the existing RAMtop, reduces it by 116 bytes, then destroys itself by performing New. Because it is self-destructive, remember to Save it on tape before running it! While running, it comes up with:

```
TO VERIFY RAND USR X
```

where x is a number shown. Make a note of this number — it will be used later.

Program 2 is the verify routine. It sits in a Rem statement in line 1. After typing Rem, a follow it with 116 characters — I usually use 0. To load the machine-code program into the Rem, Run program 2. The machine-code loader used has become pretty standard in *Your Computer*. Enter the code in hexadecimal, either as a single byte plus Newline, for example, 76 N/L, or as a block at a time for example 7676CD230F plus N/L. Make sure each byte consists of two digits for example 0F and not F.

Once the machine-code program has been loaded, delete lines 10 to 90. Then put in line 10:

```
10 RAND USR 16632
```

Also Poke 16510,0. This will change the Rem line number to 0 — a safer approach since line 0 cannot be deleted. Now Save program 2 on

(continued on page 67)

NEW TITLE

ZX SPECTRUM USER'S HANDBOOK
Robert J Simpson and **Trevor J Terrell**

- **Includes original programs in BASIC and machine code**
- **Illustrations include eight colour plates**
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(continued from page 65)

tape. The two Halt instructions at the beginning of the machine-code program are there to prevent the contents of the Rem statement from being listed. This is preferable for two reasons — one to prevent an awful mess from being listed and, secondly, if the machine-code program is longer than can be listed on to the screen, the ZX-81 will effectively crash.

Now Run the program. It will relocate the routine to above RAMtop, changing three absolute Calls at the same time to the correct address. It will then perform New — thus destroying the Basic program.

Now to use Verify. First put in a Basic program and Save it. Rewind the tape back to the start of the program just saved, then Rand Usr x as a direct command — where x is that number you wrote down from program 1 — remember? Now press Play on the tape recorder. Three types of report code can be shown:

0/0 program verified and is OK
D/0 Break key pressed during Verify
E/0 Error has been found on tape.

D/0 is similar to when Break is pressed during normal Load and Save. Note the use of E/0 — Sinclair does not use this report code. If an error has been found, your original program has not been destroyed — try listing it! Just re-Save the program and do Verify again.

The Verify routine does not check if system variables have been saved satisfactorily — during Verification many would be different to when saved. In between saving and verifying, do not change any user variables or define new ones — they would be different to those stored on tape and an error would be shown. The Verify program can be used within a Basic program also, for example:

```
100 SAVE "EXAMPLE"
110 PRINT "REWIND TAPE TO START OF
    EXAMPLE"
120 PRINT "THEN PRESS PLAY ON TAPE
    RECORDER"
130 PRINT "PRESS G KEY WHEN YOU HAVE
    DONE THIS"
140 IF INKEY$ <> "G" THEN GOTO 140
150 RAND USR X
```

Where X is the start of the Verify program — again the one you wrote down. ■

Program 1.

```
10 LET X=PEEK 16308+256*PEEK 16309
20 LET X=X-116
30 LET T=X/256
40 LET H=INT T
50 LET L=(T-H)*256
60 POKE 16308,L
70 POKE 16309,H
80 PRINT "TO VERIFY USE  RAND USR ";X
90 PRINT "   PRESS ANY KEY TO CONTINUE"
100 IF INKEY$="" THEN GOTO 100
110 NEW
```

Program 2.

```
1 REM (fill this with 116 characters)
10 LET X=16514
20 LET A$=""
30 IF A$="" THEN INPUT A$
40 IF A$="S" THEN STOP
50 POKE X,16*CODE A$+CODE A$(2)-476
60 PRINT AT 11,7;X;" ";A$(1 TO 2)
70 LET X=X+1
80 LET A$=A$(3 TO)
90 GOTO 30
RUN (in FAST)
```

The Verify routine in machine code.

```
4082            76          HALT                        ;To prevent screen listing
4083            76          HALT
4084            CD230F      CALL 0F23,FAST
4087            37          SCF
4088            CB12        RL  D
408A            CB0A        RRC D
408C  NEXT PROG CD9140      CALL 4091,INBYTE            ;Start tape listen
408F            18FB        JR  408C,NEXT PROG
4091  IN BYTE   0E01        LD  C,01
4093  NEXT BIT  0600        LD  B,00
4095  BREAK1    3E7F        LD  A,7F
4097            DBFE        IN  A,(+FE)                 ;Test for BREAK key
4099            D3FF        OUT (+FF),A                 ;Echo to screen
409B            1F          RRA
409C            3005        JR  C,40A3,CONT1            ;JR if BREAK not pressed
409E  BREAK2    CD2B0F      CALL 0F2B,SLOW
40A1            CF          RST 08H                     ; > REPORT CODE D
40A2            0C          DEFB 0C                     ; > BREAK key pressed
40A3  CONT1     17          RLA
40A4            17          RLA
40A5            3034        JR  C,40DB,GET BYTE         JR Build up byte in C Reg.
40A7            10EC        DJNZ 4095,BREAK1
40A9            F1          POP AF
40AA  PROG NAME CD9140      CALL 4091,IN BYTE
40AD            79          LD  A,C                     ;Load built up byte into A
40AE            17          RLA                         ;Bit 7 of byte into Carry
40AF            30F9        JR  NC,40AA,PROG NAME       ;JR if not last byte of name
40B1            218940      LD  HL,4089,VERSN           ;Start loading from 4089
40B4  VERIFY    CD9140      CALL 4091,IN BYTE           ;Byte from tape into C reg.
40B7            117940      LD  DE,4079                 ;Start of Basic prog. into DE
40BA            A7          AND A                       ;Clear carry
40BB            E5          PUSH HL                     ;Save address count
40BC            ED52        SBC HL,DE                   ;Are we up to Basic prog?
40BE            E1          POP HL                      ;Retrieve address count
40BF            3004        JR  C,40C5,CONT2            ;And if not,do not verify
40C1            79          LD  A,C                     ;Byte from tape into A
40C2            BE          CP  (HL)                    ;Do Byte VERIFY
40C3            2011        JR  NZ,40D6,ERROR           ;JR ERROR if verify false
40C5  CONT2     23          INC HL                      ;HL points to next address
40C6            ED5B1440    LD  DE,(E-LINE)
40CA            A7          AND A                       ;Clear carry
40CB            E5          PUSH HL                     ;Save address count
40CC            ED52        SBC HL,DE                   ;Are we up to E-LINE?
40CE            E1          POP HL                      ;Retrieve address count
40CF            20E3        JR  NZ,4084,VERIFY          ;And if not cont. to verify
40D1  OK        CD2B0F      CALL 0F2B,SLOW
40D4            CF          RST 08H                     ;>No errors -
40D5            FF          DEFB FF                     ;>REPORT CODE 0
40D6  ERROR     CD2B0F      CALL 0F2B,SLOW
40D9            CF          RST 08H                     ;>ERROR -
40DA            0D          DEFB 0D                     ;>REPORT CODE E
40DB  GET BYTE  D5          PUSH DE
40DC            1E94        LD  E,94                    ;  Timing
40DE  TRAILER   061A        LD  B,1A                    ;  Loops
40E0  COUNTER   1D          DEC E
40E1            DBFE        IN  A,(+FE)                 ;Pick up tape signal
40E3            17          RLA
40E4            CB7B        BIT 7,E
40E6            7B          LD  A,E                     ;  Build up
40E7            38F5        JR  C,40DE,TRAILER          ;  Byte in
40E9            10F5        DJNZ 40E0,COUNTER           ;  C Register
40EB            D1          POP DE
40EC            2004        JR  NZ,40F2,BIT DONE
40EE            FE56        CP  56
40F0            30A1        JR  NC,4093,NEXT BIT
40F2  BIT DONE  3F          CCF
40F3            CB11        RL  C
40F5            309C        JR  NC,4093,NEXT BIT
40F7            C9          RET                         ;RETURN
40F8  BLOCKMOVE 2A0440      LD  HL,(RAMTOP)             ;Put address of RAMTOP in HL
40FB            010D00      LD  BC,000D
40FE            09          ADD HL,BC                   ;address for INBYTE in HL
40FF            228D40      LD  (400D),HL
4102            22AB40      LD  (40AB),HL
4105            228540      LD  (4085),HL
4108            218440      LD  HL,4084                 ; >Transfer programme
410B            ED5B0440    LD  DE,(RAMTOP)             ; > (4084 to 40F7)
410F            017400      LD  BC,0074                 ; >to above RAMTOP
4112          . EDB0        LDIR
4114            CDC303      CALL 03C3,NEW

     Users of old Sinclair ROMS note the following changes:
        4084-4086   CD200F
        409E-40A0   CD200F
        40D1-40D3   CD200F
        40D6-40D8   CD200F
     Or alternatively, load the machine code programme as described above,
then POKE 16517,32; POKE 16535,40; POKE 16534,40; POKE 16599,40
```

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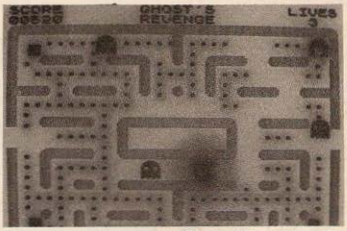

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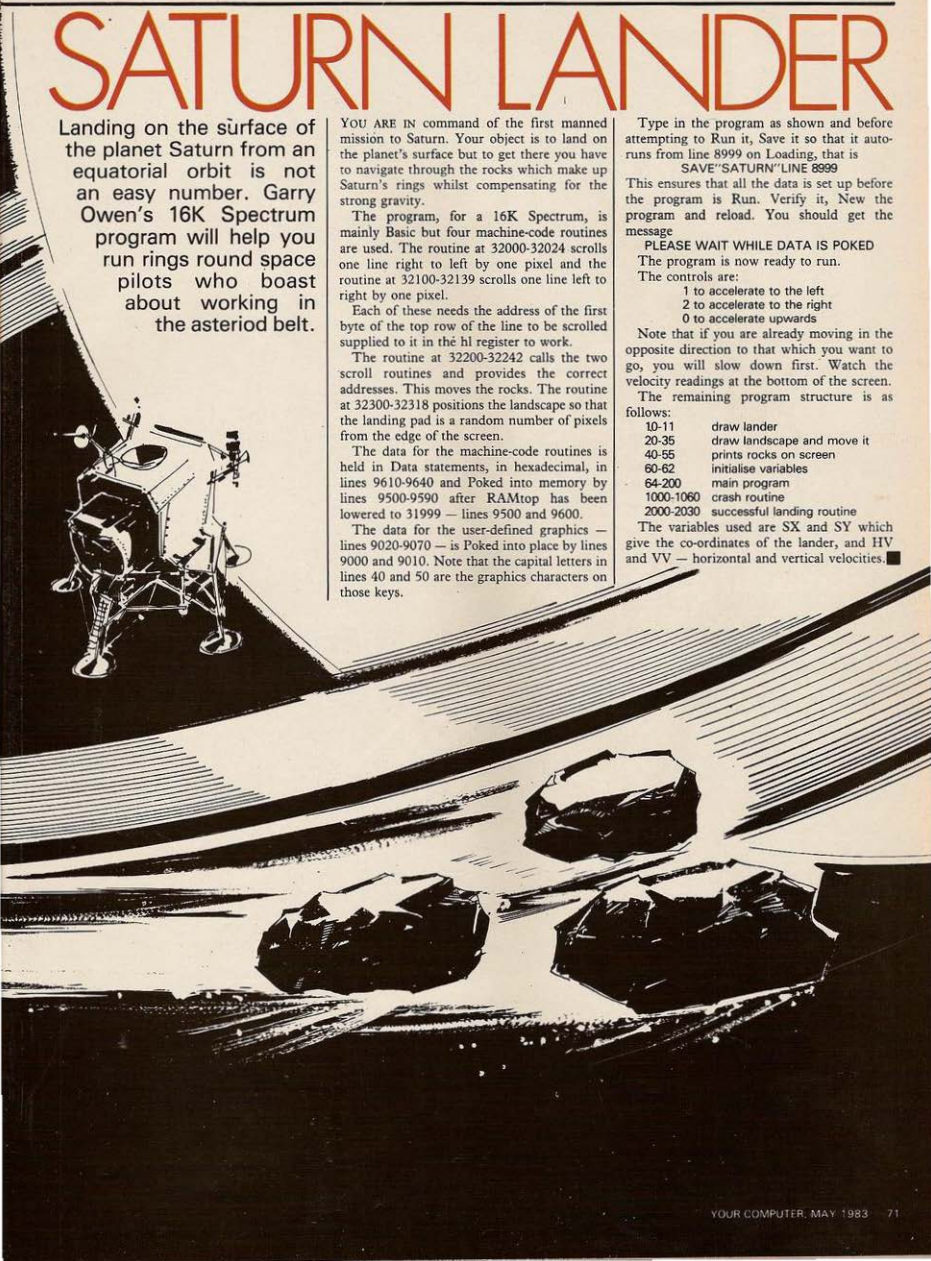
```
  1 REM SATURN LANDER
  2 REM © G. OWEN,MARCH 1983
  3 GO TO 20
 10 PLOT SX,SY: PLOT SX,SY+1: D
RAW 3,0: PLOT SX+3,SY: PLOT SX+1
,SY+2: PLOT SX+2,SY+2
 11 RETURN
 20 PAPER 0: BORDER 0: INK 5: C
LS : OVER 1
 21 PLOT 0,0: DRAW 10,20: DRAW
9,-10: DRAW 8,6: DRAW 14,-10: DR
AW 6,4
 22 DRAW 4,-4: DRAW 8,6: DRAW 1
4,-10: DRAW 16,0
 24 DRAW 0,1: DRAW -16,0: DRAW
OVER 0,16,-1
 25 DRAW 14,6: DRAW 4,-4: DRAW
18,8: DRAW 6,-2: DRAW 3,4
 26 DRAW 10,-10: DRAW 10,6: DRA
W 8,12: DRAW 10,-8: DRAW 8,4
 30 DRAW 16,-10: DRAW 24,14: DR
AW 6,-10: DRAW 4,2: DRAW 8,-10
 32 DRAW 10,-4
 35 RANDOMIZE : FOR S=1 TO RND*
100: LET L=USR 32300: NEXT S
 40 LET R$="AB  CD  AB  CD  AB
CD  AB AD CB "
 45 PRINT AT 12,0;R$;AT 15,0;R$
: LET R$=R$(15 TO )+R$( TO 14):
PRINT AT 17,0;R$
 50 LET R$="EFG  KLM   KLM   EF
G  EFG  KLM  HIJ  NOP   NOP  HI
J  HIJ  NOP   "
 55 PRINT INK 5;AT 4,0;R$;AT 8,
0;R$
 60 LET SX=RND*100+75: LET SY=1
85
 61 LET HV=0: LET VV=0
 62 LET S=0
 64 GO SUB 10
 65 IF POINT (SX,SY-1)+POINT (S
X+1,SY-1)+POINT (SX+2,SY-1)=3 TH
EN GO TO 2000
 66 LET OSX=SX: LET OSY=SY
 67 LET SX=SX+HV
 68 LET SY=SY-VV: IF SY>165 THE
N LET VV=0
 69 LET NSX=SX: LET NSY=SY: LET
 SX=OSX: LET SY=OSY
 70 GO SUB 10
 71 LET SX=NSX: LET SY=NSY
 72 LET S=S+1-(INKEY$<>"")
 75 LET L=USR 32200
 76 LET HV=HV+.25*((INKEY$="2"
AND SX<250 AND HV<=3)-(INKEY$="1
" AND SX>2 AND HV>=-3))
 77 LET VV=VV+.25-.5*(INKEY$="0
")
 78 INPUT "": PRINT #1;"VERT.VE
L=";INT (VV*100)/100,"HOR.VEL=";
INT (HV*100)/100
 80 IF POINT (SX,SY)+POINT (SX,
SY+1)+POINT (SX+1,SY+1)+POINT (S
X+1,SY+2)+POINT (SX+2,SY+1)+POIN
T (SX+2,SY+2)+POINT (SX+3,SY)+PO
INT (SX+3,SY+1)<>0 THEN GO TO 10
00
 200 GO TO 64
1000 FOR F=0 TO 30: OVER (F/2=IN
T (F/2)): INK 2: PLOT SX,SY: DRA
W 3,2
1010 PLOT SX,SY+2: DRAW 3,-2
1020 OUT 254,55*(F/2=INT (F/2))
1030 NEXT F
1035 INK 7
1040 OUT 254,0
1050 PRINT OVER 0;AT 10,11; FLAS
H 1;"GAME OVER"
1055 PRINT TAB 11;"SCORE=";S
1060 STOP
2000 IF ABS HV>.25 OR SY>5 THEN
GO TO 1000
2010 FOR X=10 TO 50 STEP 5: BEEP
.1,X: NEXT X
2015 INK 7
2020 PRINT AT 10,12; FLASH 1;"WE
LL DONE"
2030 PRINT TAB 11;"SCORE=";200-S
8998 STOP
8999 PRINT "PLEASE WAIT WHILE DA
TA IS POKED"
9000 RESTORE 9000: FOR U=0 TO 12
7
9010 READ DATUM: POKE USR "A"+U,
DATUM: NEXT U
9020 DATA 0,15,31,31,63,63,7,0,0
,192,224,248,252,252,192,0
9030 DATA 0,1,15,31,127,63,31,0,
0,224,252,254,254,248,240,0
9040 DATA 0,0,0,3,15,31,63,61,0,
0,0,248,254,255,255,255,0,0,0,0,
0,0,128,192
9050 DATA 126,127,127,127,127,63
,15,0,247,15,255,255,255,255,255
,255,224,240,BIN 10110000,BIN 10
111000,BIN 01111000,DATUM,240,0
9060 DATA 0,0,0,0,0,1,3,15,0,0,0
,0,127,255,255,255,0,0,0,0,128,2
24,240,248
9070 DATA BIN 00110111,111,111,B
IN 00110111,31,3,0,0,251,247,239
,223,255,255,0,0,248,248,240,240
,128,0,0,0
9500 RESTORE 9500: READ clr: CLE
AR clr
9505 READ ADD
9510 LET A$=""
9520 IF A$="" THEN READ A$
9525 IF A$="N" THEN GO TO 9505
9526 IF A$="S" THEN STOP
9540 IF CODE A$(1)>64 THEN LET A
$(1)=CHR$ (CODE A$(1)-7)
9550 IF CODE A$(2)>64 THEN LET A
$(2)=CHR$ (CODE A$(2)-7)
9560 POKE ADD,16*CODE A$+CODE A$
(2)-816
9570 LET ADD=ADD+1
9580 LET A$=A$(3 TO )
9590 GO TO 9520
9600 DATA 31999
9610 DATA 32000,"C5D5E5F52B11200
00508C5237ECB172BF519F10620CB162
B10FB24C110ECF1E1D1C1C9N"
9620 DATA 32100,"C5D5E5F51120000
508C52B197ECB1FF5A7ED5223F10620C
B1E2310FBA7ED5224C110E6F1E1D1C1C
9N"
9630 DATA 32200,"216040CD007D21A
040CD007D210048CD647D212048CD647
D212048CD007D21E048CD647D212050C
D007DC9N"
9640 DATA 32300,"216050CD647D218
050CD647D21A050CD647DC9N"
9700 DATA 0,"5"
```

SATURN LANDER

Landing on the surface of the planet Saturn from an equatorial orbit is not an easy number. Garry Owen's 16K Spectrum program will help you run rings round space pilots who boast about working in the asteriod belt.



YOU ARE IN command of the first manned mission to Saturn. Your object is to land on the planet's surface but to get there you have to navigate through the rocks which make up Saturn's rings whilst compensating for the strong gravity.

The program, for a 16K Spectrum, is mainly Basic but four machine-code routines are used. The routine at 32000-32024 scrolls one line right to left by one pixel and the routine at 32100-32139 scrolls one line left to right by one pixel.

Each of these needs the address of the first byte of the top row of the line to be scrolled supplied to it in the hl register to work.

The routine at 32200-32242 calls the two scroll routines and provides the correct addresses. This moves the rocks. The routine at 32300-32318 positions the landscape so that the landing pad is a random number of pixels from the edge of the screen.

The data for the machine-code routines is held in Data statements, in hexadecimal, in lines 9610-9640 and Poked into memory by lines 9500-9590 after RAMtop has been lowered to 31999 — lines 9500 and 9600.

The data for the user-defined graphics — lines 9020-9070 — is Poked into place by lines 9000 and 9010. Note that the capital letters in lines 40 and 50 are the graphics characters on those keys.

Type in the program as shown and before attempting to Run it, Save it so that it autoruns from line 8999 on Loading, that is

SAVE"SATURN"LINE 8999

This ensures that all the data is set up before the program is Run. Verify it, New the program and reload. You should get the message

PLEASE WAIT WHILE DATA IS POKED

The program is now ready to run.

The controls are:

1 to accelerate to the left
2 to accelerate to the right
0 to accelerate upwards

Note that if you are already moving in the opposite direction to that which you want to go, you will slow down first. Watch the velocity readings at the bottom of the screen.

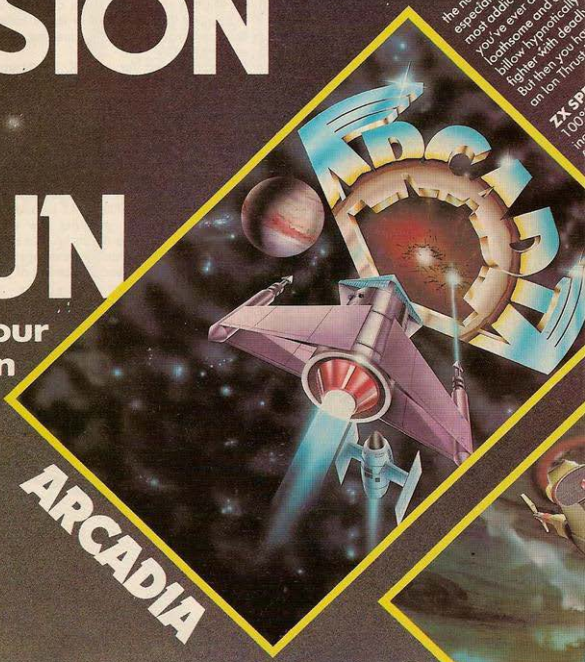
The remaining program structure is as follows:

10-11	draw lander
20-35	draw landscape and move it
40-55	prints rocks on screen
60-62	initialise variables
64-200	main program
1000-1060	crash routine
2000-2030	successful landing routine

The variables used are SX and SY which give the co-ordinates of the lander, and HV and VV — horizontal and vertical velocities. ■

THE INVASION HAS BEGUN

The assault on your senses has begun with a great choice of games that have been created to give you a real challenge!



the name of the game
especially created to be the fas
most addictive shoot 'em up
you've ever desired. Wav
loathsome and deadly
billow hypnotically
fighter with deadly
But then you be
an Ion Thrust

ZX SP
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Imagine

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e haven't you?

RUM (16K or 48K)

ade animation and explosive effects, sound and the

ed, smoothest hi-res graphics ever!

VIC-20 (any memory size)

100% machine code with eight different alien types,
smooth hi-res multicolour graphics and animation, narrow
playfield and sensational sound effects.
Keyboard or joystick.
Game design and software by D. H. Lawson.

for any ZX SPECTRUM.

It's my own fault, I even volunteered.
I thought that with the space-dazed and its shovel and skyhook
it would be easy shifting the galaxy's rubbish.
Childs play. HUH! They wanted me of the weird packaging,
the trays, the rods, and all the rest.
But they didn't say I'd have to stop and control not just one but two
or even more garbage pods. Then prod them, push
them, toward that black hole, and oh, it's so very, very
black, and so lonely, so empty.
Panic, mustn't panic, but they won't stop, waiting and
spinning and turning, always turning, towards me, against
me, at me. And I'm alone.
No way out, nowhere to hide, on my own, my own... own...
SCHIZOIDS: NOT JUST A GAME, BUT A STATE OF MIND.
SCHIZOIDS features real-time animated 3d graphics for a
breathtaking visual experience, plus sound and all those arcade
features you'd expect from IMAGINE.
Game design and software by Peter Paranoid and
the Yrd Kids. (D.H.L.)

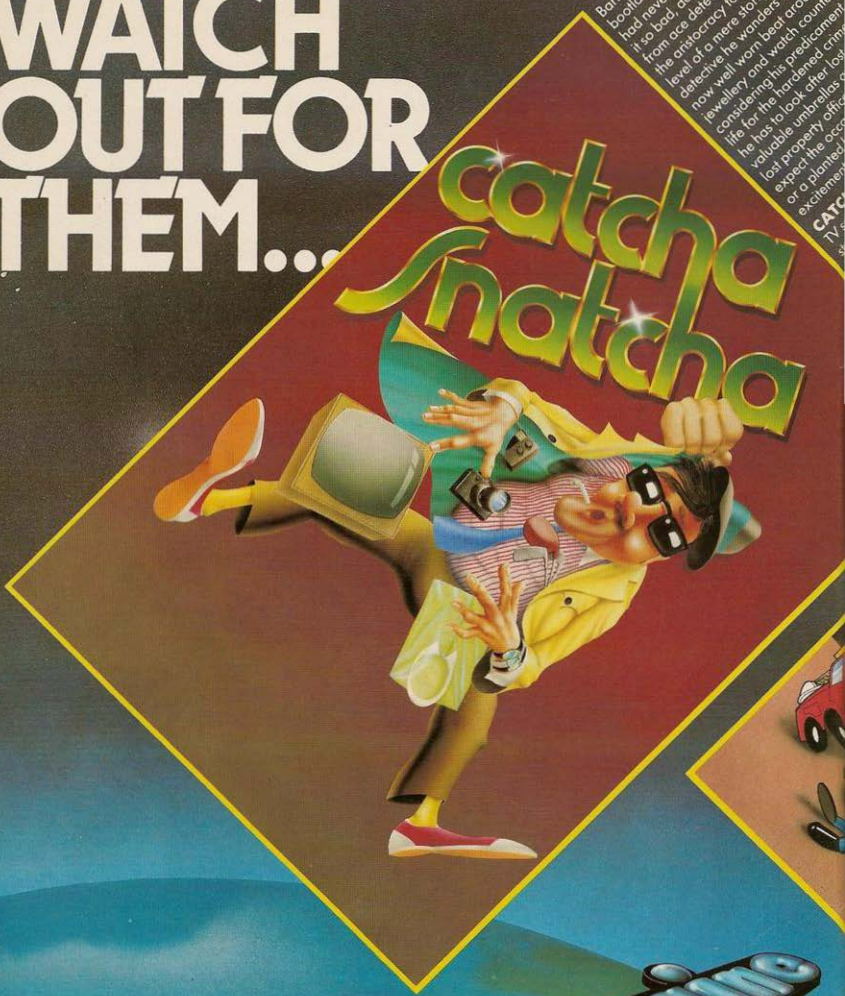
the wildest, zanied way of earning a
fast buck. With crazy diners screaming for
service you're gonna have to be
quick to pick up the tips, don't stop the drinks,
as you dodge the drunks and
dart from elevator to elevator, coz if the Boss
man spots you, your gonna be
out on your but. 100% machine code,
incredible animation, super smooth hi-res
multicolour graphics, authentic
sound effects and special playfield.
Keyboard or joystick control.
Yet another high performance
Arcade quality experience
for any Commodore Vic-20.
Game design and
software by
Eugene Evans.

WACKY WAITERS

WATCH OUT FOR THEM...

Barney Boollace had never had it so bad, demoted from ace detective of the aristocracy to the level of a mere store detective he wanders his now well worn beat around the jewellery and watch counters considering his predicament life for the hardened crim he has to look after lost valuable umbrellas o expect the occa lost property offic or a planted excitement

CATC TV s



Imagine

..the name of the game

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Of course one can
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omb to add to the fun and

A SNATCHA brings to your
een the mad, mad world of the
e detective in what has to be the most
aotic super store ever built with hordes
of harassed housewives doing their
weekly shopping. And you just wait till
the late-night shopping starts.

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Hi-Res multicoloured graphics, sound,
multiple playfields and a real time clock.
100% machine code. Keyboard or
joystick.

Game design and software by
Eugene Evans.

for any Commodore Vic-20.

for any ZX SPECTRUM.
Are you just the average teddy.
Are you teddy enough to
take on the terrors of the
toybox in an epic struggle to fulfill your
true role in life – to reach and comfort your
crying baby? To boldly go where no teddy
has gone before. To overcome incredible
odds, to take on and fight the clockwork
soldiers, the mammoth dolls, the train set, the
play people, and the murderous plasticine.
With only the bear essentials – your
wellington boot, your beachball and faithful
old peashooter – for your defence and your
only ally the lark in the Box, you will need
to build stairways from the play bricks
around you to reach your baby without
getting the stuffing knocked out of you.

AH DIDDUMS features multiple
toyboxes with progressive difficulty
levels, super cute – super detailed
animation, sound and those fast
smooth graphics that only
IMAGINE can produce.
100% machine code.

Game design
and software by
D. H. Lawson.

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METHOD: GEO-GRAVITATIONAL MINING.
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e to combat. Only tales exist to describe the
band of aliens awaiting you in the depths. Tales of
e beast and many more which exist only as myths . . .
e time being?
hand you have the very latest mining equipment, 2-way
radar indicates approaching aliens from above, below and all
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Game design and software by Eugene Evans.

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"Well, if you brushed your teeth more often Malcolm, you
wouldn't have to. Remember what that nice man from Imagine
told you about those horrible DK's. They'll rot your teeth away if
you don't brush them. And it's no use trying to clean them if you've
no toothpaste on the brush. You had better stop eating all that junk
food as well, it only makes the DK's even more evil."
Poor Malcolm. He didn't heed our warning and now he's suffering the
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With just a toothbrush and a tube of Imagico toothpaste at your
disposal, can you keep the DK threat at by and avoid a painful visit
to the dentist?
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Game design and software
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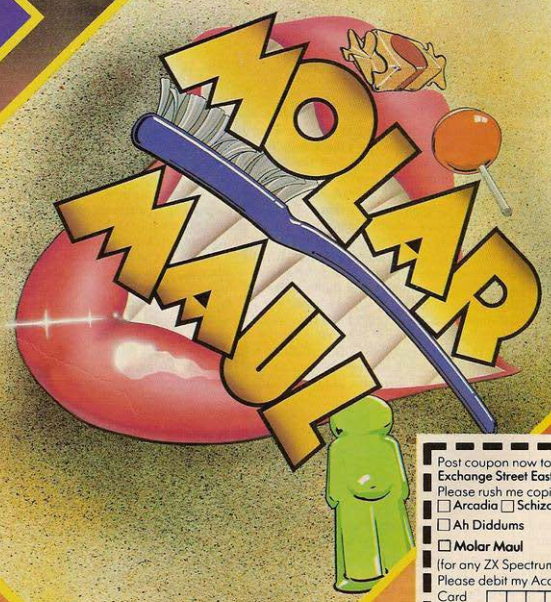

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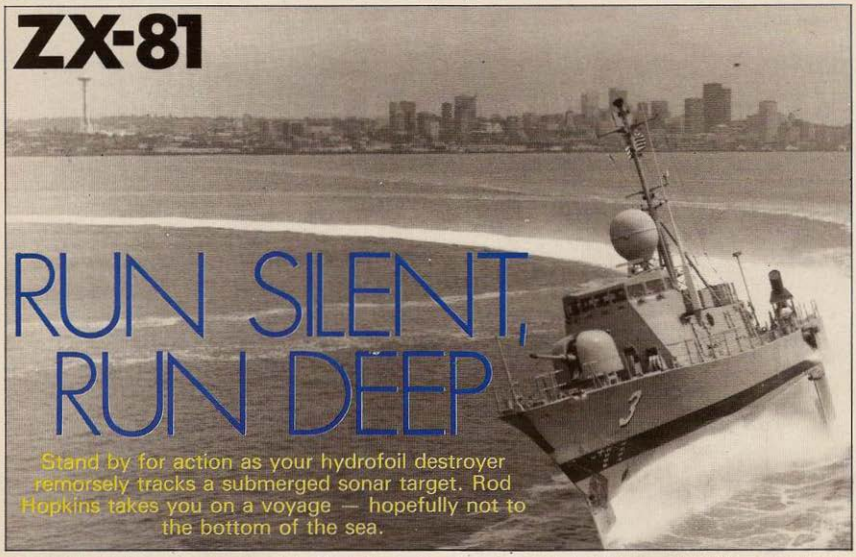

RUN SILENT, RUN DEEP

Stand by for action as your hydrofoil destroyer remorsely tracks a submerged sonar target. Rod Hopkins takes you on a voyage — hopefully not to the bottom of the sea.

A DESTROYER LURKS on a storm-tossed sea, lying in wait for passing submarines — the object, of course, being to destroy one. This game has been written in machine code, and uses imaginative display.

The first and most obvious benefit accruing from the use of machine code is that of speed of execution. Basic is a general-purpose, high-level language designed to cope with an infinite variety of programming needs. A machine-code programmer, on the other hand, can confine his attention to the particular needs of the moment. The result is that a lot of time-consuming classification of tasks, of fetching and carrying can be avoided. A Basic program is ultimately performed as a machine-code sequence of course, but an awful amount of sorting and organising must be carried out by the interpreter during its execution.

A second, and directly-related advantage to be gained from writing in code is that of compactness. This factor is of overriding importance when programming the unexpanded ZX-81, for the simple reason that the machine can arrogate to itself nearly all of the available RAM. Of 1024 bytes of user memory, about 125 are occupied by system variables; a further 700-odd by a 22-line display, and a smallish, variable number by stacks and marker bytes. You will not need a calculator to work out that very little is left over for controlling that power station.

Sinclair sidestepped the problem of the insatiable demands of screen RAM by arranging that display RAM only be allocated as it was demanded, a CLS reducing this allocation to a minimum of 25 end-of-line markers. Basic being rather wasteful of memory, programmers in that language for the 1K machine are forced to make constant use of this facility to contract the display file.

The technique is this: to clear the screen each program cycle and reprint the display, in order that unused but opened display lines should not accumulate an overhead of wasted RAM. Economy results, but unfortunately with a fairly paralysing strobe-effect. In machine code, a sufficiency of display RAM can be permanently opened, and the display given a feel of continuity and fluidity. Naturally, if enough memory were to hand, and a fast interpreter, then the pros and cons would need to be reargued.

For the current program, a decimal dump is provided in figure 1, disassembled in figure 2. It will be noted that some use of Sinclair's ROM has been made.

The first address shown in the dump is 16514, indicating that the code is to be stored in a Rem statement occupying the first Basic line of the program. Therefore, type:

```
1 REM 110 CHARACTERS . . .
```

whichever you like.

Having done this, type

```
PRINT PEEK 16511
```

the result should be 112. If it is not, then edit line 1 and delete or add characters as appropriate. Once line 1 is correct, edit it twice, changing the line number to 2 and 3 respectively. You should now have three Rem statements each containing 110 characters. Now type:

```
POKE 16511,88
POKE 16512,1
```

and in effect, a single Rem statement having 342 characters remains. The stage is now set for entering the machine code. To prevent an unbreakable listing loop occurring after the code has been entered, the two first characters Poked will be Newlines, or end-of-line markers. This has the effect that the default list line will always be line one. However, to list subsequent lines, simply type List 2. Remember to delete the loader when entering has been completed.

Typing in the code using the loader of figure 4 should not take more than about 10 or 15 minutes, forbidding though the dissassembly looks. As bytes are entered, the format of figure 1 is reproduced on the screen to allow straightforward checking of each entry as it is made.

Figure 3 lists the massive Basic part of the program. Do not be tempted to add frills; they

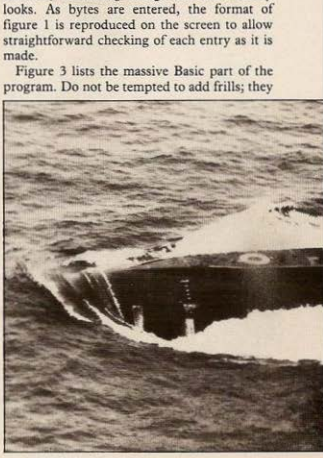

Figure 1.

16513	118	112	42	12	64	
16519	229	17	7	0	25	
16524	34	14	64	0	64	
16529	175	215	15	253	6	
16534	32	62	10	215	16	
16539	253	0	0	1	175	
16544	215	11	120	177	32	
16549	249	225	30	51	25	
16554	34	60	64	205	135	
16559	65	62	255	50	70	
16564	64	42	123	64	35	
16569	34	123	64	126	33	
16574	70	64	52	38	230	
16579	7	60	60	50	62	
16584	64	198	7	119	61	
16589	14	26	205	245	8	
16594	42	14	64	34	64	
16599	64	22	0	0	0	
16604	42	64	64	229	6	
16609	5	113	35	16	252	
16614	225	42	34	64	64	
16619	126	254	110	40	197	
16624	6	5	54	131	35	
16629	16	251	43	43	43	
16634	54	174	56	92	54	
16639	230	30	79	6	8	
16644	205	245	8	42	14	
16649	64	22	0	126	254	
16654	10	62	10	32	1	
16659	61	119	6	2	197	
16664	42	60	64	58	37	
16669	64	254	247	32	12	
16674	43	126	254	110	40	
16679	29	34	60	64	205	
16684	135	65	254	239	32	
16689	17	35	229	30	7	
16694	25	126	254	110	225	
16699	48	9	34	60	64	
16704	205	135	65	193	15	
16709	209	24	2	24	146	
16714	237	75	98	64	42	
16719	58	64	203	65	32	
16724	18	42	58	64	30	
16729	36	25	58	27	64	
16734	254	253	32	21	12	
16739	58	62	64	71	114	
16744	38	33	25	16	3	
16749	19	24	7	126	254	
16754	174	54	52	40	50	
16759	237	67	66	64	34	
16764	58	64	9	60	13	
16769	32	253	18	201	24	
16774	193	1	118	7	38	
16779	33	42	58	64	229	
16784	229	43	126	195	40	
16789	5	114	167	237	82	
16794	114	225	62	120	119	
16799	35	16	252	126	105	
16804	40	1	114	225	167	
16809	237	82	54	135	35	
16814	54	130	35	114	201	
16819	1	23	52	42	54	
16824	54	43	113	35	54	
16829	30	35	112	35	112	
16834	35	54	38	35	113	
16839	1	0	0	205	245	
16844	8	237	75	70	64	
16849	6	0	201			

will almost certainly lead to an out of memory report.

Keyboard decoding has been arranged to suit the destroyer skipper wearing regulation Arctic-issue mittens: any key 1 through 5 will move the ship left, while any key 6 to 0 will move it to the right. Pressing F releases a depth charge. As normal, these devices are set to trigger at the supposed depth of the submarine. This particular destroyer has excellent sonar; its charges always go off at the appropriate depth. They must, however, drop into the conning tower to produce the desired effect. To alter the speed at which events take place, try Poking different values into address 16767.

Figure 2.

```
U-BOAT HUNT DISSASSEMBLY

INITSCRN  LD HL,
          (DISPLAY FILE)
          PUSH HL
          LD DE,7
          ADD HL,DE
          LD(DFCC),HL
          LD B,64
ZEROACC   XOR A
          RST 10H
          DJNZ ZEROACC
          LD B,4
          LD A,CODE "■"
PRTACC    RST 10H
          DJNZ PRTACC
          LD BC,256
BLANKLNS  XOR A
          RST 10H
          DEC BC
          LD A,B
          OR C
          JR NZ,BLANKLNS
INITSHIP  POP HL
          LD E,51
          ADD HL,DE
          LD(SHIPAD),HL
          CALL PRTSHIP
          LD A,255
          LD(SUBCOUNT),A
NEWSUB    LD HL, (RAND)
          INC HL
          LD(RAND),HL
          LD A,(HL)
          LD HL,SUBCOUNT
          INC (HL)
          INC HL
          AND 7
          INC A
          INC A
          LD(SUBLINE),A
          ADD 7
          LD(HL),A
          LD B,A
          LD C,26
          CALL PRTPOS
          LD HL,(DFCC)
          LD(SUBAD),HL
          LD HL,(SUBAD)
          PUSH HL
          LD B,5
          LD(HL),C
          INC HL
          DJNZ -4
          POP HL
          DEC HL
          LD(SUBAD),HL
          LD A,(HL)
          CP NEULINE
          JRZ NEWSUB
          LD B,5
          LD(HL),CODE "■"
          INC HL
          DJNZ -5
          DEC HL
          DEC HL
          DEC HL
          LD(HL),CODE "■"
WAVES     LD A,(FRAMES)
          AND 38
          LD C,A
          LD B,8
          CALL PRTPOS
          LD HL,(DFCC)
          LD D,0
          LD A,(HL)
          CP "■"
          LD A,CODE "■"
          JR Z,1
          DEC A
          LD(HL),A
MOVESHIP  LD B,2
ACTION?   PUSH BC
          LD HL,(SHIPAD)
          LD A,(LAST-K)
LEFT ?    CP 247
          JR NZ,RIGHT ?
          DEC HL
          LD A,(HL)
          CP NEULINE
          JR Z,DCHARGE
          LD(SHIPAD),HL
          CALL PRTSHIP
RIGHT ?   CP 239
          JR NZ,DCHARGE
          INC HL
          PUSH HL
          LD E,7
          ADD HL,DE
          LD Z,(HL)
          CP NEULINE
          POP HL
          JR Z,DCHARGE
          LD(SHIPAD),HL
          CALL PRTSHIP
          POP BC
          DJNZ ACTION?
          JR DCHARGE
JUMP      JR PRTSUB
DCHARGE   LD BC,(DCIND)
          LD HL,(DCAD)
          BIT 0,C?
          JR NZ,BLANKDC
          LD HL,(SHIPAD)
          LD E,36
          ADD HL,DE
          LD A,(LAST-K)
DCHARGE?  CP 253
          JR NZ,STODC
          INC C
          LD A,(SUBLINE)
          LD B,A
BLANKDC   LD(HL),D
          LD E,33
          ADD HL,DE
          DJNZ PRTDC
          INC C
          JR STODC
PRTDC     LD A,(HL)
          CP CONNINGTOWER
          LD(HL),CODE "O"
          JR Z,EXIT
STODC     LD(DCIND),BC
          LD(DCAD),HL
DELAY     LD B,MAINCOUNT
LOOP      DEC C
          JR NZ,LOOP
          DJNZ LOOP
          JR JUMP
PRTSHIP   LD BC,NEULINE
          /SHIPLEN
          LD E,LINEINC
          LD HL,(SHIPAD)
          PUSH HL
          PUSH HL
          DEC HL
          LD A,(HL)
          CP C
          JR Z,5
          LD(HL),D
          AND A
          SBC HL,DE
          LD(HL),D
          POP HL
          LD A,CODE "■"
PRTBLK    LD(HL),A
          INC HL
          DJNZ PRTBLK
          LD A,(HL)
          CP C
          JR Z,1
          LD(HL),D
          POP HL
          SBC HL,DE
          LD(HL),"■"
          INC HL
          LD(HL),"■"
          INC HL
          LD(HL),D
          RET
EXIT      LD BC,#/0
          LD HL,(SUBAD)
          DEC HL
          LD(HL),"*"
          INC HL
          LD(HL),"B"
          INC HL
          LD(HL),"O"
          INC HL
          LD(HL),"O"
          INC HL
          LD(HL),"M"
          INC HL
          LD(HL),"*"
          LD BC,0
          CALL PRTPOS
          LD BC,(SUBCOUNT)
          LD B,0
          RET
```

Figure 3.

```
BASIC PROGRAMME
10 PRINT USR 16515;
   "    SUB5 ESCAPED"
15 INPUT A$
20 RUN
```

Figure 4.

```
LOADER ROUTINE
10 FOR N=1 TO 338 STEP 5
15 SCROLL
20 PRINT 16513+N;
25 FOR K=0 TO 4
30 INPUT I
35 POKE 16513+N+K,I
40 PRINT TAB (7+K*5);I;
45 IF N+K=338 THEN STOP
50 NEXT K
55 PRINT
60 NEXT N
```

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BREAK THROUGH THE BBC OPERATING SYSTEM

BBC

Chris Melville's last two articles delved into the BBC operating system — now you can break out.

THE PROGRAM published here is a Basic-driven assembly language program to play either Breakout or Breakthrough. It uses pixel graphics in Mode 7 so that it should run on a model A if you miss out all the comments and put multiple assembler statements per line. Using pixels in mode 7 needs some fiddling which would slow down a Basic program too much to make a challenging game, but this one is both fast and smooth. It was intended as an example of how the MOS calls would be used in games programming. There is not a direct memory reference in the whole program — unusual for a game — so the program will run on any operating system and also with the 6502A second processor installed. The features are: selectable bat size, increasing game speed as score increases, selectable initial hardness, selectable bat speed relative to ball, selectable number of balls per game, wall lowers every time you get through the last one, breakout or breakthrough, and high score.

Some of the operating system calls are as follows:

Purpose	Line numbers	MOS routine
Produce a beep	680-710	OSWORD(7)
Perform Tab	950-1000	OSWRCH(31)
Examine character at cursor position.	1020-1030	OSBYTE(135)

(continued on page 83)

The Breakout program.

```
 10NERROR RUN
 100TV255,0
 20MODE7
 30 PROCSETUP
 40PROCCOURT
 50CALLPIP
 60PRINTTAB(24,0);!S%;'IF?BC<54 AND?BY<21 GOTO50
 70TIME=0:REPEAT SOUND &12,-8,TIME,5: UNTIL TIME>200
 80SOUND&11,-15,0,5:IF ?BC=54 ?XV=?XV *2*RND(2)-3):?YV=255:GOTO40
 90?YV=0-ABS(?YV):BL%=BL%-1:PRINTTAB(37,0);BL%
 100IF BL%>0 ?XV=ABS(?XV):GOTO50
 110 IF !S%>HI_SCORE HI_SCORE=!S%
 120PRINTTAB(3,16)CHR*133"HIT 'G'-ANOTHER GAME  OR"CHR*151;TAB(2,17)CHR*134"'ES
CAPE'-START FROM BEGINNING"CHR*151;
 130IF NOT INKEY(-84) GOTO130
 140?XV=(2*RND(2)-3):?YV=255:?WS=1:BL%=BALLS%:!(S%)=0:GOTO40
 150DEF PROCCOURT:LOCAL I%,J%
 155CLS
 160IF ?WS<11 AND ?BC=54 ?WS=?WS+2
 170CLS:PRINT:FOR I%=0 TO 22:PRINTCHR*152:NEXT
 180PRINTTAB(1,1)STRING$(38,CHR*112)
 190
 200FORI%=2 TO23:PRINTTAB(1,I%)CHR*181;TAB(38,I%)CHR*234;:NEXT
 210FORI%=?WS+2 TO ?WS+7:PRINTTAB(2,I%)STRING$(36,CHR*124):NEXT
 220FORI%=1 TO ?WS +1:PRINTTAB(0,I%)CHR*151:NEXT
 230RESTORE:FOR I%=1 TO 6:READJ%:PRINTCHR$J%;:NEXT
 240REPEAT:PRINTCHR*151;UNTIL  VPOS=23
 250 DATA147,150,146,149,145,148
 260T%=RND(15)+2
 270?BC=0:?BP=19:?PB=39:?DB=1:PRINTTAB(19,21);CHR*42;STRING$(?BL-1,CHR*47);CHR*
37
 280?BX=T%:?LX=T%:?BY=20:?LY=20:?PX=T%*2:?PY=60:?DX=0:?DY=0:PRINTTAB(T%,20)CHR*
33
 290PRINTTAB(1,0)CHR*131;"HI_Score:";CHR*135;HI_SCORE;TAB(16,0)CHR*133;"Score:"
;CHR*134;!S%;TAB(29,0);CHR*130;"Balls:";CHR*131;BL%
 300REPEAT UNTIL INKEY(-99)
 310ENDPROC
 320DEF PROCSETUP
 330OSWORD=&FFF1:OSWRCH=&FFEE:OSBYTE=&FFF4
 340VDU23;8202;0;0;0;
 350DIM DOT 5,T1 0,T2 0,T3 0,T4 0,BX 0,BY 0,PX 0,PY 0,XV 0,YV 0,BP 0,PB 0,BL 0,
```

(listing continued on page 83)

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*(reg. TM)

(listing continued from page 81)

```
BV 0,BG 0,BEEP 0,WS 0,SX 3,DX 0,DY 0,DB 0,LX 0,LY 0,SPEED 0,THRU 0,LEVEL 15
 360TDOT=161:?(DOT+1)=162:?(DOT+2)=164
 370?(DOT+3)=169:?(DOT+4)=176:?(DOT+5)=224
 380!(BEEP)=&FFF10011:!(BEEP+4)=&5000F
 390?SPEED=30:!SX=0:?WS=1:?XV=1:?YV=255
 400PITCH=BEEP+4:HI_SCORE=0
 410 PROCASSEMBLE
 420PROCINSTRUCTIONS
 430ENDPROC
 440DEF FNGETBETWEEN(X,J%):LOCAL K%
 450 PRINT" (";X;" to ";J%;")";CHR$135)
 460REPEAT:K%=GET-ASC"0":UNTIL K%>=X AND K%<=J%
 470PRINTCHR$(K%+ASC"0")
 480=K%
 490DEF PROCINSTRUCTIONS:CLS
 500CLS:PRINT'CHR$131,"B R E A K O U T          C.MELVILLE '83"
 510PRINTCHR$145;STRING$(&15,"-");SPC(5);STRING$(&15,"-")
 520PRINT'CHR$134;"Input no. of balls Per game ";BALLS%=FNGETBETWEEN(1,5):BL%=
BALLS%
 530PRINT'CHR$130;"Input initial bat size";?BL=FNGETBETWEEN(1,5)
 540PRINT'CHR$133;"Input bat speed ";?BV=FNGETBETWEEN(1,4)
 550PRINT'CHR$130;"Hit 0 for breakTHROUGH".REPEAT X$=GET$:UNTIL
X$="0" OR X$="T":IF X$="0" ?THRU=0 ELSE ?THRU=255
 560PRINT'CHR$134;"Input initial game speed";:H%=FNGETBETWEEN(1,3)
 570 PRINT''CHR$129;"Z-bat left.X-bat right. SPACE BAR-serve";
 580 PRINT'CHR$135,"          key to start ...."
 590 X=GET
 600IF H%>1 !(LEVEL)=&1E23282B:!(LEVEL+4)=&18191A1C:!(LEVEL+8)=&12131416:!(LEVE
L+12)=&080C0F11 ELSE!(LEVEL)=&18191A1C:!(LEVEL+4)=&12131416:!(LEVEL+8)=&080C0F11
:!(LEVEL+12)=&080C0F11
 610IFH%=3 !(LEVEL)=&12131416:!(LEVEL+4)=&080C0F11:!(LEVEL+8)=&080C0F11:!(LEVEL
+12)=&080C0FF11
 620ENDPROC
 630DEF PROCASSEMBLE:LOCAL PASS%
 640DIM FREE%2000
 650FOR PASS%=0 TO 2 STEP2
 660P%=FREE%
 670C OPT PASS%
 680.PIP  LDX #BEEP MOD 256
 690      LDY #BEEP DIV 256
 700      LDA #7          \SET UP OSWORD
 710      JSR OSWORD      \DO A BEEP
 720.BALL LDA PX          \FIND NEW
 730JSR DELRY
 740      CLC             \PIXEL  POS.
 750      ADC XV          \OF BALL BY
 760      STA PX          \ADDING ON
 770      LDA PY          \X,Y VELOCITY
 780      CLC             \COMPONENTS
 790      ADC YV          \TO  OLD POS.
 800      STA PY
 810
 820      LDA PX          \WORK OUT TAB
 830      LSR A           \POSITION OF
 840      STA BX          \BALL
 850
 860      LDA PY
 870      LDY #255        \WORK OUT TAB
 880.SUB  INY:SEC         \POS. OF Y
 890      SBC #3          \COORD. OF
 900      BCS SUB         \BALL AND ITS
 910      CLC:ADC #3      \PIXEL HEIGHT
920      STY BY          \ABOVE Y-CD.
 930      STA DY
 940
 950      LDA #31         \CODE FOR TAB
 960      JSR OSWRCH
 970      LDA BX          \MOVE TO X,Y
 980      JSR OSWRCH      \POS.OF BALL
 990      LDA BY
 1000     JSR OSWRCH
 1010
 1020     LDA #135        \EXAMINE CHAR
 1030     JSR OSBYTE      \ALREADY HERE
 1040     STX T1          \ + PUT IN T1
 1050
 1060     LDA T1          \SEE IF IT IS
 1070     CMP #112        \PART OF TOP
 1080     BNE SKP1        \WALL,IF SO
 1090     JMP LID         \GO TO "LIC"
 1100
 1110.SKP1 CMP #181       \SEE IF IT IS
 1120     BNE SKP2        \PART OF LEFT
 1130     JMP SIDE        \SIDE WALL...
 1140
 1150.SKP2 CMP #234       \AND SAME FOR
 1160     BNE SKP3        \RIGHT WALL..
1170     JMP SIDE
 1180
 1190.SKP3 CMP #47        \IF IT WAS
 1200     BNE SKK2        \PART OF BAT
 1210     JMP BAT         \GO TO "BAT"
 1220
 1230.SKK2 CMP #42        \ALSO TEST FOR
   BNE SKK1        \A HIT ON THE
 1250     JMP LBAT        \SIDE OF BAT
 1260
 1270.SKK1 CMP #37        \AND OTHER ONE
 1280     BNE SKK3
 1290     JMP RBAT
 1300
 1310.SKK3 LDA BY         \IF BALL HAS
 1320     CMP #21         \GONE OUT.
 1330     BNE SKP4        \RETURN TO
 1340     RTS             \BASIC.
 1350
 1360.SKP4 LDA T1         \SEE IF BALL
 1370     CMP #124        \HAS HIT A
 1380     BNE SKP5        \BRICK,IF SO
 1390     JMP BRICK       \GOTO"BRICK"
 1400
 1410.SKP5 LDA #31        \MOVE TO TAB
 1420     JSR OSWRCH      \POS. OF LAST
 1430     LDA LX          \POS. OF BALL
 1440     JSR OSWRCH      \AND RUB IT
 1450     LDA LY          \OUT
 1460     JSR OSWRCH
 1470     LDA #BSC" "
 1480     JSR OSWRCH
 1490
 1500     LDA PX          \FIND PIXEL
 1510     AND #1          \INSIDE X-CD.
 1520     STA DX          \OF BALL.
 1530
 1540     CLC:ADC DY      \USE LOOK-UP
 1550     CLC:ADC DY      \TABLE TO
 1560     TAX             \DECIDE WHICH
 1570     LDA DOT,X       \GRAPHICS CHR
 1580     STA T2          \IS REQUIRED.
 1590
 1600     LDA #31         \DO A TAB,AND
 1610     JSR OSWRCH      \PRINT THE
 1620     LDA BX          \GRAPHICS
 1630     JSR OSWRCH      \CHARACTER
 1640     LDA BY          \THAT WAS
 1650     JSR OSWRCH      \WORKED OUT
 1660     LDA T2          \TO REPRISENT
 1670     JSR OSWRCH      \THE BALL.
 1680
 1690     LDA BX:STA LX   \SET NEW LAST
 1700     LDA BY:STA LY   \COORDINATES.
 1710
 1720\THE NEXT SECTION IS RESPONSIBLE
 1730\FOR SCANNING THE KEYBOARD AND
 1740\MOVING BAT ACCORDINGLY.
 1750
 1760.MBAT LDA #129       \TEST Z,X KEYS
 1770     LDY #&FF        \USING THE OS
 1780     LDX #&D0        \OSBYTE 129
 1790     JSR OSBYTE      \EQUIVALENT OF
 1800     TYA:BMI XGOT    \INKEY(-67)
 1810     LDA #129        \OR INKEY(-98)
 1820     LDY #&FF        \AND BRANCH TO
 1830     LDX #L9E        \CORRESPONDING
 1840     JSR OSBYTE      \BAT-MOVING
 1850     TYA             \ROUTINES IF
 1860     BMI ZGOT        \Z,X PRESSED
 1870
 1880.KBD2 JMP BALL \RETURN TO START.
 1890
 1900.XGOT LDA BV:STA T1  \FIND VALUE
 1910      JMP BT1        \TO BE ADDED
 1920.ZGOT LDA #0:SEC     \TO BAT POS.
 1930      SBC BV         \AND STORE
 1940      STA T1         \IT IN T1.
 1950
 1960.BT1  LDA #31        \MOVE TO TAB
 1970      JSR OSWRCH     \POS.OF START
 1980      LDA BP         \OF BAT.
 1990      JSR OSWRCH
 2000      LDA #21
 2010      JSR OSWRCH
 2020
 2030      LDY BL         \NEXT FEW
 2040      LDA #BSC" "    \LINES DEALS
 2050.BT2  JSR OSWRCH     \WITH RUBBING
 2060      DEY:BNE BT2    \OUT OLD BAT.
 2070      LDA DB
 2080      BEQ BT3
 2090      LDA #BSC" ":JSR OSWRCH
 2100
 2110.BT3  LDA PB         \NEXT SECTION
 2120      CLC:ADC T1     \WORKS OUT
 2130      STA T2         \POSITIONAL
 2140      AND #1:STA T3  \DETAILS OF
 2150      LDA T2:LSR A   \NEW BAT AND
 2160      STA T4         \STORES THEM.
 2170
 2180      CLC            \WORK OUT END
 2190      ADC BL         \POS.OF BAT
 2200      CLC            \AND SEE IF
 2210      ADC T3         \TOO FAR TO
 2220      CMP #39        \RIGHT@(IF SO
 2230      BCC BTT        \DO NEXT BIT)
 2240      LDA #38        \MOVE BAT TO
 2250      SEC:SBC BL     \RIGHTMOST
 2260      STA BP         \POSITION
 2270      ASL A:STA PB
 2280      LDA #0:STA DB
 2290      JMP BT4
 2300
 2310.BTT  LDA T4         \HAS BAT HIT
 2320      CMP #2         \WALL AT LEFT
 2330      BCS BTO        \NO-SKIP
 2340      LDA #4:STA PB
 2350      LDA #0:STA DB
 2360      LDA #2:STA BP
 2370      JMP BT4
 2380
 2390.BTO  LDA T2:STA PB  \TRANSFER
 2400      LDA T3:STA DB  \TO PERMANENT
 2410      LDA T4:STA BP  \REGISTERS.
 2420
 2430.BT4  LDA #31        \DRAW BAT AT
 2440      JSR OSWRCH     \POSITION
2450      LDA BP         \GIVEN BY THE
 2460      JSR OSWRCH     \CONTENTS OF
 2470      LDA #21        \THE PERMNT.
 2480      JSR OSWRCH     \REGISTERS.
 2490      LDA DB
 2500      BEQ BT5
 2510      LDA #42:JMP BT6
 2520.BT5  LDA #47
 2530.BT6  JSR OSWRCH
 2540      LDY BL:LDA #47
 2550.BT7  DEY:BEQ BT8
 2560      JSR OSWRCH
 2570      JMP BT7
 2580.BT8  LDA DB
 2590      BEQ BT9
 2600      LDA #37:JSR OSWRCH
 2610.BT9  JMP BALL \RETURN TO START
 2620
 2630
 2640\THE NEXT BIT IS THE ROUTINE FOR
 2650\WHEN THA BALL HITS THE "ROOF"
 2660
 2670.LID  LDA PX:CMP #4:BNE LD0
 2680      LDA PY:CMP #6:BNE LD0
 2690      LDA #0:SEC:SBC XV:STA XV
 2700.LD0  LDA #150         \SET UP PITCH
 2710.LD1  STA PITCH        \TO BE BEEPED
 2720      LDA #0           \NEGATE AND
 2730      SEC:SBC YV       \RE-STORE Y
 2740      STA YV           \COMPONENT OF
 2750      JMP PIP          \BALL VELOITY
 2760
 2770\AND WHEN THE BALL HITS THE SIDE
 2780
 2790.SIDE LDA #90          \AS BEFORE...
 2800      STA PITCH
 2810      LDA #0
 2820      SEC:SBC XV
 2830      STA XV
 2840      LDA BY
 2850      CMP #21
 2860      BCC SID1
 2870      LDA PB
 2880      CMP #5
 2890      BCC SID2
 2900      JMP SKK3
 2910.SID2 LDA #0:SEC:SBC YV:STA YV
 2920.SID1 JMP PIP
 2930
 2940\AND WHEN THE BALL HITS THE BAT
 2950
 2960.BAT  LDA XV           \BALL LEAVES
 2970      BMI B1           \MIDDLE OF BAT
```

(continued on page 85)

(continued from page 81)

Perform Tab	
Test z and x keys on keyboard	1760-1790 OSBYTE(129)
Printing spaces to rub out bat	2030-2090 OSWRCH

They are repeated at several different places in the program. The assembly code is fully commented so it should be possible to develop the game further if required.

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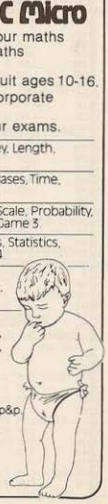

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(continued from page 83)

```
2980        LDY #1        \WITH UNIT X
2990        STY XV        \VELOCITY IN
3000        JMP B2        \MAGNITUDE
3010.B1     LDY #255
3020        STY XV
3030.B2     LDA #10
3040        JMP LD1
3050
3060.RBAT LDA #2          \IF BALL HIT
3070        STA XV        \EDGE OF BAT
3080        JMP B2       \DIFFERENT
3090.LBAT LDA #254        \BOUNCING
3100        STA XV        \OCCURS
3110        JMP B2
3120
3130\THE NEXT SECTION DEALS WITH THE
3140\BALL HAVING HIT A BRICK.
3150
3160.BRICK LDA #8         \WORK OUT THE
3170        SEC           \ROW NUMBER
3180        SBC BY        \AND PUT IT
3190        CLC           \IN T1.
3200        ADC WS
3210        STA T1
3220
3230        LDA BX        \NOW WORK OUT
3240        SEC:SBC #2    \THE START
3250        AND #&FC      \POS.OF BRICK
3260        CLC:ADC #2
3270        STA T2        \ =T2
3280
3290        LDA #31       \DO A TAB TO
3300        JSR OSWRCH    \THEBEGINNING
3310        LDA T2        \OF THE BRICK
3320        JSR OSWRCH
3330        LDA BY
3340        JSR OSWRCH
3350
3360        LDA #ASC" "   \NOW BLANK OUT
3370        JSR OSWRCH    \BRICK
3380        JSR OSWRCH
3390        JSR OSWRCH
3400        JSR OSWRCH
3410
3420        LDA T1        \WORK OUT
3430        TAX           \PITCH OFBEEP
3440        ASL A
3450        ASL A
3460        ASL A
3470        ASL A
3480        STA PITCH
3490
3500        TXA           \INCREMENT
3510        CLC:ADC S%    \SCORE AS PER
3520        STA S%        \ROW HIT.
3530        LDA #0        \NOTE-SCORE
3540        ADC S%+1      \IS A 2-BYTE
3550        STA S%+1      \QUANTITY
3560        JSR PRMS      \THIS ROUTINE CHECKS HOW HIGH THE SCORE IS AND
CHANGES THE DIFFICULTY ACCORDINGLY.
3570
3580      LDA THRU        \NEGATE Y-CMP
3590      BMI IBC         \OF VELOCITY
3600       LDA #0         \IF NOT
3610       SEC:SBC YV     \BREAKTHROUGH
3620       STA YV
3630
3640.IBC LDA BC
3650       CLC:ADC #1     \INCREMENT
3660       STA BC         \BRICK COUNT
3670
3680       LDA #0:TAY:TAX:RTS  \RETURN TO BASIC WITH ALL REGISTERS ZERO'D
3690
3700\ THE FOLLOWING SUBROUTINE USES A LOOK UP TABLE CALLED "LEVEL" TO DECIDE
ON THE SPEED OF THE GAME FOR ANY PARTICULAR SCORE LESS THAN 1024
3710.PRMS LDX S%+1        \GET SCOREHIGH
3720       LDY S%         \GET SCORE LOW
3730       TXA:ROR A
3740       TAX:TYA
3750       ROR A:TAY:TXA
3760       ROR A:TAX:TYA
3770       ROR A:TAY
3780       LSR A:LSR A:LSR A:LSR A
3790       TAX:LDA LEVEL,X:STA SPEED:RTS
3800.DELAY PHA:TYA:PHA:TXA:PHA
3810       LDX SPEED
3820.D2    LDY #255
3830.D1    DEY:BNE D1
3840       DEX:BNE D2
3850       PLA:TAX:PLA:TAY:PLA:RTS
3860]
3870NEXT PASS%
3880ENDPROC
```

■

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```
FILL
BACKGROUND
(ASCII CODE- )
RST 24          223
LD HL (9216)     33    0    36
LD B (23)         6   23
PUSH BC         197
LD B (32)         6   32
LD A (HL)       126
CP (32)         254   32
JRNZ (+2)        32    2
LD A E          123
LD (HL) A       119
INC HL           35
DJNZ (-10)       16  246
POP BC          193
DJNZ (-16)       16  240
JP (IY)         253  233
```

```
FILL
FOREGROUND
(ASCII CODE- )
RST 24          223
LD HL (9216)     33    0 36
LD B (23)         6   23
PUSH BC         197
LD B (32)         6   32
LD A (HL)       126
CP (32)         254   32
JRZ (+2)         40    2
LD A E          123
LD (HL) A       119
INC HL           35
DJNZ (-10)       16  246
POP BC          193
DJNZ (-16)       16  240
JP (IY)         253  233
```

```
SEARCH&
REPLACE
(ASCII CODE SEARCH
 ASCII CODE REPLACE- )
RST 24          223
LD C E           75
RST 24          223
LD HL (9216)     33    0    36
LD B (23)         6   23
PUSH BC         197
LD B (32)         6   32
LD A (HL)       126
CP E            187
JRNZ (+2)        32    2
LD A C          121
LD (HL) A       119
INC HL           35
DJNZ (-9)        16  247
POP BC          193
DJNZ (-15)       16  241
JP (IY)         253  233
```

```
INVERT
( - )
LD HL (9216)     33    0    36
LD B (23)         6   23
PUSH BC         197
LD B (32)         6   32
LD A (HL)       126
ADD A (128)     198  128
LD (HL) A       119
INC HL           35
DJNZ (-7)        16  249
POP BC          193
DJNZ (-13)       16  243
JP (IY)         253  233
```

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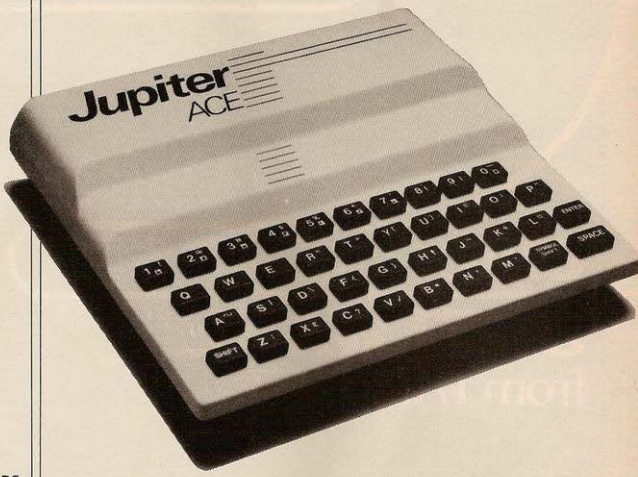

Forth is fast, but a little bit of machine code will take you through the light barrier. Simon Cross shows you how to accelerate your Jupiter Ace with this handy kit of 10 screen-handling routines for those situations where Forth is still not quite fast enough and the ultimate speed of machine code is what you require.

THE JUPITER ACE offers an alternative for those who wish to write fast arcade games but cannot face the sometimes daunting challenge presented by machine code. The speed advantage that Forth has over Basic enables the games programmer to write "space-invader" type programs without reaching for an assembler. However, there are still some situations where Forth is not quite fast enough and the ultimate speed of machine code is required.

One such situation is writing screen-handling routines such as scrolling. Try this Forth word which fills the screen with a character specified by an ASCII code taken from the top of the stack:

```
: FILL
  9952 9216
  DO
    DUP I C!
  LOOP
  DROP
;
```

Execute this word by typing an ASCII code followed by "fill", for example "42 fill" will produce a screenful of stars. It can be seen that although the screen is filled quite rapidly, the process of printing is visible passing in a wave from the top to the bottom of the screen. When this routine is written in machine code the process appears to be instantaneous; this is useful for creating explosion effects and the like. The difference in speed between Forth and machine code becomes more marked with more complex routines such as scrolling.

Even when routines have to be written in machine code the Forth environment still has

(continued on page 89)

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(continued from page 87)
some advantages. The routine can initially be written in Forth to test its function in the context of the complete program, particularly its effects on the stack. If the routine works it can be translated into machine code without any alterations to the rest of the program. The routine is called by its name which is more convenient than Rand Usr followed by the address, the technique some Basics use. The main advantage is that since Forth words can be moved around the dictionary by Redefine and Load the machine code must be relocatable.

This article describes 10 screen-handling words written in machine code for the Jupiter Ace. Any combination of them may be included in ordinary Forth programs where speed is important. No knowledge of machine code is required to use them since once they have been entered they act like any other words in the Forth dictionary. The simplest way to enter the code is by using the defining word "Code" described on page 147 of the Jupiter Ace manual:

```
DEFINER CODE
DOES>
 CALL
;
```

The machine code is entered by typing Code then the name of the word followed by the decimal code, each byte being separated by C,. For example the Scrollup routine would be entered by typing:

```
CODE SCROLLUP 33 C, 32 C, 36 C,
              17 C, 0 C, etc.
```

On pressing Enter the whole typed section will be copied to the upper screen and OK will appear after it. The word can then be executed by typing its name, for example:

```
SCROLLUP
```

Code is not a very user-friendly word but, since it is not possible to delete it from the dictionary when the code has been entered, it is important that it should not take up much memory space.

The 10 words will fit into the unexpanded 3K Jupiter Ace, but this does not leave much memory space in which to write programs to utilise the routines. It is better to only enter the words necessary for a specific program.

Here is a description of the individual words: Scrollup scrolls the entire screen one line up and blanks the bottom line; Scrolldown scrolls the entire screen one line down and blanks the top line; Scrollright scrolls the entire screen one column to the right and blanks the left-hand column; and Scrollleft scrolls the entire screen one column to the left and blanks the right-hand column.

Fillscreen fills the screen with a character specified by an ASCII code which should be put on the stack before the word is executed. Fillscreen uses the RST 24 routine in the ROM which takes off the top of the Forth stack and puts it in the DE register pair. Fillforeground fills all the non-blank areas of the screen with a character specified by an ASCII code on the stack. Fillbackground fills all the blank areas of the screen with a character specified by an ASCII code on the stack.

Search&replace takes two numbers from the stack. The first number is the ASCII code of the character to be searched for on the screen. Any occurrence of this character is replaced by another character whose ASCII code is given by the second number. This word is useful to selectively "flash" parts of the screen for explosions or countdowns.

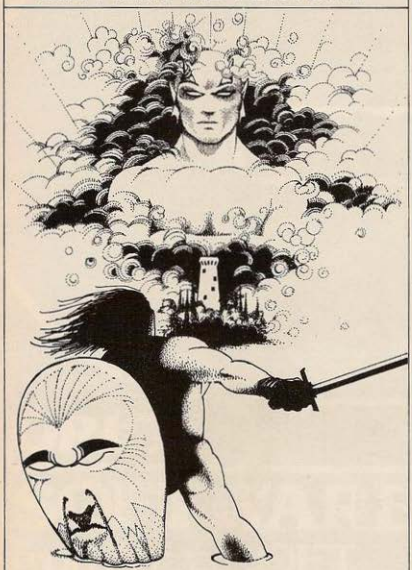
Invert turns all the characters on the screen into their inverse forms. It is useful for explosion effects when used in loops such as this:

```
: BANG
  21 1
  DO
   INVERT I 10 * 60 BEEP
  LOOP
;
```

Border prints a border round the edge of the screen using the character specified by an ASCII code on the stack. ■

```
SCROLLUP
( - )
LD HL (9248)  33   32   36
LD DE (9216)  17    0   36
LD B (22)      6   22
PUSH BC      197
LD B (32)      6   32
LD A (HL)    126
EX DE HL     235
LD (HL) A    119
INC HL        35
EX DE HL     235
INC HL        35
DJNZ (-8)     16  248
POP BC       193
DJNZ (-14)    16  242
DEC HL        43
LD A (32)     62   32
LD B A        71
LD (HL) A    119
DEC HL        43
DJNZ (-4)     16  252
JP (IY)      253  233

SCROLLDOWN
( - )
LD HL (9919)  33  191   38
LD DE (9951)  17  223   38
LD B (22)      6   22
PUSH BC      197
LD B (32)      6   32
LD A (HL)    126
EX DE HL     235
LD (HL) A    119
DEC HL        43
EX DE HL     235
DEC HL        43
DJNZ (-8)     16  248
POP BC       193
DJNZ (-14)    16  242
INC HL        35
LD A (32)     62   32
LD B A        71
LD (HL) A    119
INC HL        35
DJNZ (-4)     16  252
JP (IY)      253  233

SCROLLRIGHT
( - )
LD HL (9950)  33  222   38
LD DE (9951)  17  223   38
LD B (23)      6   23
PUSH BC      197
LD B (31)      6   31
LD A (HL)    126
EX DE HL     235
LD (HL) A    119
DEC HL        43
EX DE HL     235
DEC HL        43
DJNZ (-8)     16  248
EX DE HL     235
LD A (32)     62   32
LD (HL) A    119
DEC HL        43
EX DE HL     235
DEC HL        43
POP BC       193
DJNZ (-21)    16  235
JP (IY)      253  233

SCROLLLEFT
( - )
LD HL (9217)  33    1   36
LD DE (9216)  17    0   36
LD B (23)      6   23
PUSH BC      197
LD B (31)      6   31
LD A (HL)    126
EX DE HL     235
LD (HL) A    119
INC HL        35
EX DE HL     235
INC HL        35
DJNZ (-8)     16  248
EX DE HL     235
LD A (32)     62   32
LD (HL) A    119
INC HL        35
EX DE HL     235
INC HL        35
POP BC       193
DJNZ (-21)    16  235
JP (IY)      253  233

FILLSCREEN
(ASCII CODE- )
RST 24       223
LD A E       123
LD HL (9216)  33    0   36
LD B (23)      6   23
PUSH BC      197
LD B (32)      6   32
LD (HL) A    119
INC HL        35
DJNZ (-4)     16  252
POP BC       193
DJNZ (-10)    16  246
JP (IY)      253  233

BORDER
(ASCII CODE- )
RST 24       223
LD A E       123
LD HL (9216)  33    0   36
LD B (32)      6   32
LD (HL) A    119
INC HL        35
DJNZ (-4)     16  252
LD DE (31)    17   31    0
LD B (21)      6   21
LD (HL) A    119
ADD HL DE     25
LD (HL) A    119
INC HL        35
DJNZ (-6)     16  250
LD B (32)      6   32
LD (HL) A    119
INC HL        35
DJNZ (-4)     16  252
JP (IY)      253  233
```

SPECTRUM 48K : ZX81 16K
SIX PART ADVENTURE



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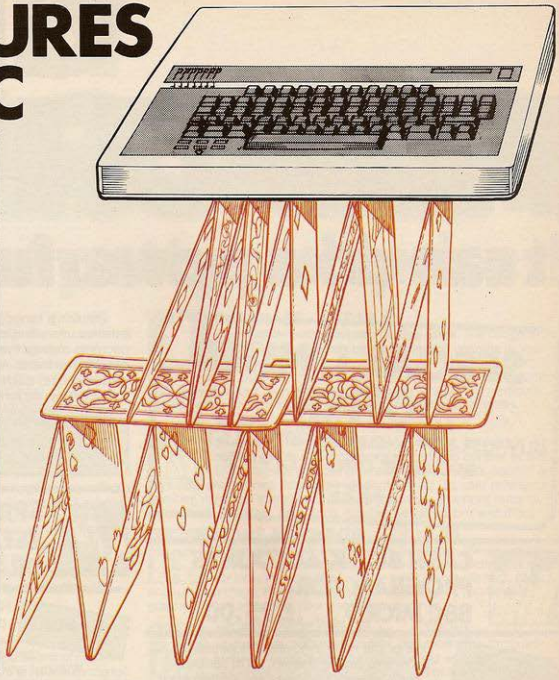
Woodward and Berry's card game makes learning structures fun.



WE ALL KNOW what it is like — you get a brilliant idea, so you dash to the machine, and start bashing keys in excitement. Hours later, what seemed to be so straightforward has become a nightmare. So, you down the last coffee, dump the program to tape, and stagger off to bed, hoping it will be all right in the morning. In fact, next morning your program looks for all the world as though it were the work of an alien intelligence. You plod through it, trying to remember what the variables represent, and just why you added that complicated set of conditions to statement 10204. The logical paths through your program intertwine, like a bowl of spaghetti.

This does not prove that you are not cut out for programming. The job did not go wrong because of lack of programming skill — it was doomed from the moment you switched on the machine because you started unprepared. Programming is an error-prone business — a spelling mistake in a letter is pretty trivial, but in a computer program absolute accuracy is crucial.

Although errors are inevitable, the earlier in the development process they are discovered, the easier and quicker it will be to fix them.

The most efficient, accurate, testable and maintainable computer programs are those whose structure most closely resembles the job

HOUSE OF CARDS

that the program has been designed to do.

Writing programs that work, and completing them before you get fed up with them, is fun. Unless we pay due regard to the above maxim, that fun will be replaced by misery and frustration. So, what we want is a methodology for approaching this programming task — and structured programming is just that.

Let's go back to that wonderful inspirational moment when the idea comes. Instead of rushing to your machine and spoiling it all, grab a piece of paper and write down in plain language what the objective of the program is. The original statement is usually termed "the problem". Next, try to break down the main problem into subordinate problems, the essential things your program has to achieve to solve the problem. You can continue in this way, building a hierachy of problems at increasing levels of detail.

So far, this may all sound pretty trite — where is the methodology? There are many different schemes to be found in books and in use, but they all attempt to show the same things: a hierachy of problems; decisions or branches; loops or iterations.

From now on, we will try to explain the process by developing a program to play the card game of Pelmanism. If you are not familiar with the game, do not worry — all will be revealed as we proceed. You will acquire the necessary knowledge as your analysis gets deeper into the problem. Approaching problem analysis in this layered way is called top-down design.

Figure 1 shows a possible first-level breakdown of the Pelmanism problem. The main problem, "Play Pelmanism", is found to consist of two sub-problems, "Set up game" and "Play Game". The diagram is read top-to-bottom, left to right, so the diagram tells you that you have to set up the game before you can play it.

We discover that set-up consists of getting a pack of playing cards, shuffling them, and then laying them all, face down, in random places on the table. Figure 2 shows how these sequential tasks are added to the diagram.

That is probably as far as we need to go at present in the set-up problem area, so let us now analyse the play-game problem. We discover the rules are that two players take turns. At each turn, the player turns up two cards. If they are of the same value, for example two kings, the player gets a point, and the cards are removed.

If they are not of the same value, they are replaced in their original positions, face down. So, we have a loop — rotate around the players in turn — and a decision — if the cards match, do one thing, otherwise do something else. Figure 3 shows how the play-game problem can be broken down to incorporate these tasks, and includes the loop and the decision. The loops are represented by curved arrows. The decision is represented by a little diamond.

It should be apparent that what happens on Player B's turn is essentially the same as happens for Player A. We have revealed a whole chunk of problem which might have

(continued on page 99)

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Dragon 32K or 64k	●				●			●	
VIC20 (16k+)	●	●	●	●				●	●
Sinclair ZX81 (16k+)	●								
Grundy Newbrain	●								
Texas TI99/4A	●								
Atari 400/800 or Odesma 1	●								
Sharp MZ80A	●	●	●	●				●	●
Sharp MZ80K	●	●	●	●				●	●
Sharp MZ80B	●	●	●	●				●	●
BBC micro model A or B 32K	●	●	●	●	●	●	●	●	●

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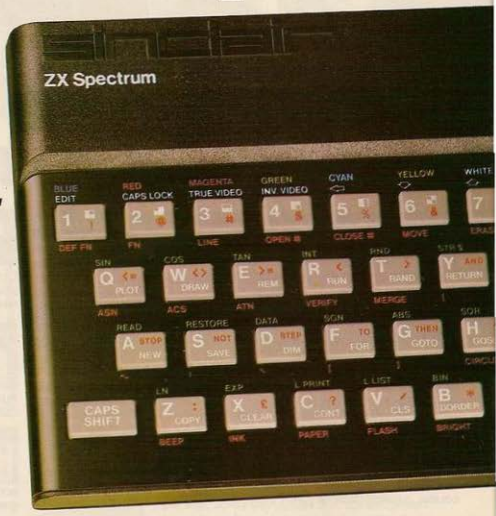

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Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

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There's no need to stop there. The ZX Printer – available now – is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.

Key features of the Sinclair ZX Spectrum

- Full colour – 8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
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- Massive RAM – 16K or 48K.
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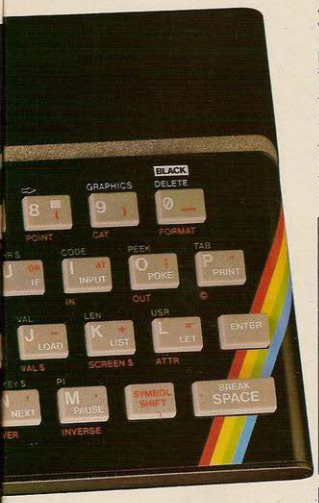

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ZX Expansion Module

This module incorporates the three functions of Microdrive controller, local area network, and RS232 interface. Connect it to your Spectrum and you can control up to eight Microdrives, communicate with other computers, and drive a wide range of printers.

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Tel: Camberley (0276) 685311.

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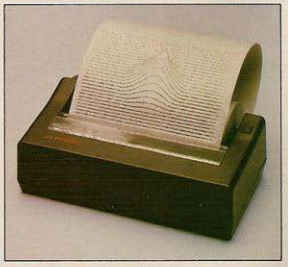
The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.



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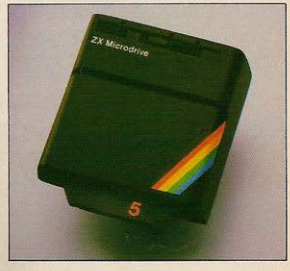
A remarkable breakthrough at a remarkable price. The Microdrives will be available in the early part of 1983 for around £50.



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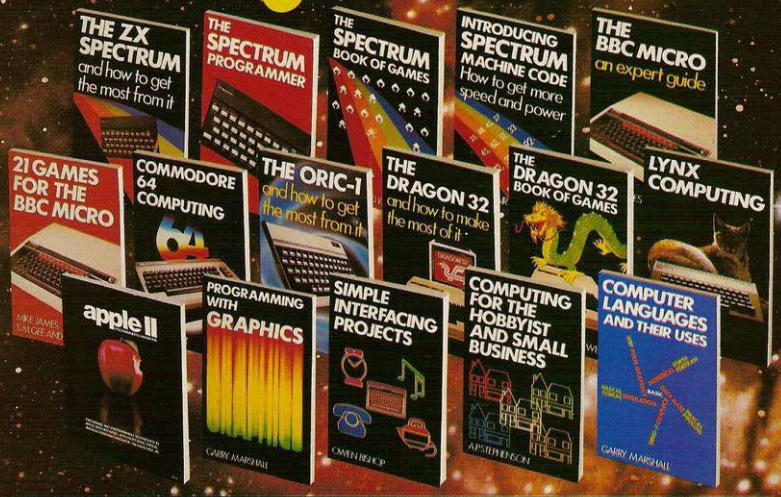

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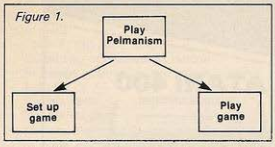
(continued from page 91)

Figure 1.



resulted in duplicate code, had we started to program too early. Of course, most of you would have spotted such duplication straight away, but the principle is valid. If it occurred at a lower level, you might not have recognised it. There is no need to duplicate parts of the diagram, so we simply put the note "as for player A" under "Player B's turn" — see Figure 3.

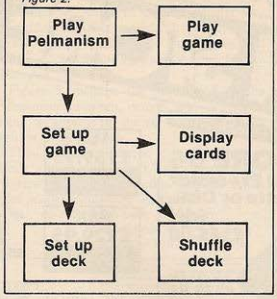
Just identifying a loop is hardly sufficient — we have to say what stops it. Once again, this is expressed in plain words — no flags to be used at this stage, please! Therefore, in Figure 3, we have added legends like "Repeat until all the cards have been paired" to the arrows representing the loops. Similarly, we have defined the decisions, but, because of lack of space, these definitions appear as footnotes. The other addition in Figure 3 is the box "Print Results". We have decided that, at the end of the game, we should display the scores.

We hope you can see already that this is an easy-to-understand representation of the game problem. You will notice that it describes the Problem, and not the Solution — so it is just as appropriate as a description of the game as played with cards as of its simulation on the computer. Therefore, when you do eventually code it, your program will represent reality, will correspond closely in structure to your design solution, and you will be able to enhance it later, if you wish.

Notice also that the structure diagram is universal, and is not tied to any particular programming language or dialect, or to any particular computer. For example, we have not said whether the loops will be implemented as "For-Next", "Repeat-Until" or "Do-While".

Now, although we have some way to go to fully define the problem, at the level of detail required for a complete solution, we could at this stage start to write the program. The

Figure 2.



essence of the structured "top-down" approach is that it does make it possible to develop programs in a modular way. Let us take the low-level boxes, such as "Pick a card". They are still black boxes at this stage, and can be coded as dummy procedures or sub-routines. Such dummies are known in the trade as "stubs". You can then run and test your skeleton program for basic errors. If you include temporary Print statements within your "stubs", you can prove to yourself that the procedures or sub-routines are being entered and left in the correct sequence. Note that you may have to force the program to proceed from one state to another by other temporary statements. Take the following example:

```
  10 PROCA (or GOSUB 1010)
  20 FLAG=0
  30 REPEAT
  40 PROCB (or GOSUB 2010)
  50 UNTIL FLAG=1
  60 PROCC (or GOSUB 3010)
  70 END
1000 DEF PROCA (not required for GOSUB)
1010 PRINT "PROCA HAS BEEN EXECUTED"
1999 ENDPROC (or RETURN)
2000 DEF PROCB (not required for GOSUB)
2010 PRINT "PROCB HAS BEEN EXECUTED"
2999 ENDPROC (or RETURN)
3000 DEF PROCC (not required for GOSUB)
3010 PRINT "PROCC HAS BEEN EXECUTED"
3999 END PROC (or RETURN)
```

Clearly, the program will get stuck in the loop which calls procedure B for ever and a day. Of course, the real code to be placed in procedure B will do something which results in Flag being set to "1", but you have not written this yet. So, once you have tested the program as above, simply insert a new statement 2020, setting Flag equal to "1". This will force the program to leave the loop and execute the later code.

To return to the Pelmanism problem, we are approaching an adequate definition, but need to be more precise. For example, the box "Pick a card" needs to be expanded as in figure 4.

Let us now recap on what we have been doing. First, we defined our problem at the highest meaningful level, then at the next level down. We were then able to code our program in skeleton form. As further understanding came, we could expand our structured design downwards into increasing levels of detail, and, at each level, could insert code into "black boxes". This process can be summarised as:

DEFINE OBJECTIVE
DEFINE PROBLEM ELEMENTS
AT CURRENT LEVEL
CODE SKELETON SOLUTION
IF PROGRAM COMPLETE, STOP
OTHERWISE

The more astute of you will be a little cynical about the glib way we suggest you flip from adding a box to the diagram to actually coding it — and quite right, too. The coded solution to one box may, of course, be far from simple. It may require some thought as to how you can program it. Again, we urge you not to try to develop this code at the keyboard. You will find your time is far more productive if you try to sketch out the required code beforehand, using some kind of shorthand notation. This is where we can learn from the experience of professionals, and introduce the concept of "pseudo-code".

Various academics have written doubtless worthy tomes on language systems for pseudo-code. Some advocate a free-form representation, similar to Basic, whilst others prefer to have you fill in complicated-looking forms. Our advice is to forget all that, unless you are intent on immersing your hobby in a bureaucracy. You should develop your own shorthand notation — after all, you are the only person who will have to understand it. It is different for professionals in a big department, where other programmers have to pick up the documentation and work from it.

What does pseudo-code look like? It is somewhere between a precise form of English and the program code itself. Its syntax is loose, but its format should be consistent and clear. The pseudo code for the box "Set-up game" in the Pelmanism problem could be:

Proc set up game
— Set up deck
— Set up a string of card values

(continued on page 101)

Figure 3.

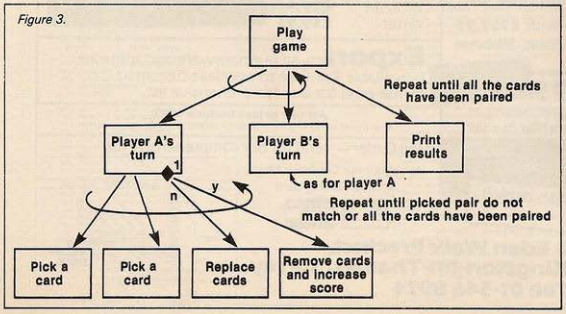
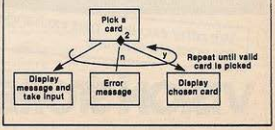


Figure 4.



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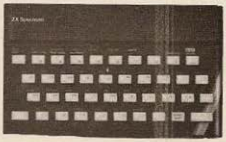

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(continued from page 99)

— Establish address of string
Shuffle cards
— For I = 1 to 20
— Select two card values at random
— Exchange position of card values in string
— Next I
— Display cards
End Proc set-up game

You can see that pseudo-code enables you to resolve most of the problems due to logical flow, off-line. Nothing you do here can wreck the work you have already coded. Once you have fully desk-checked your pseudo-code, it is a straightforward matter to put it into the pedantic language your computer expects.

We know from experience that this methodology works — not just for us, but for thousands of people in the professional programming business as well. It produces the correct results quicker, and that, as we said earlier, does make programming considerably more fun.

Figure 5 contains the full listing of the Pelmanism program, which was developed using a structured design approach. It is written in BBC Basic.

This particular solution uses the Teletext Mode (7), but it could, with benefit, be adapted to use high-resolution graphics mode, with proper pictures of the cards.

Lines 40-110	Main body of program Call routines to Set-up game Play game and Print results
Lines 120-470	Procedure to set up game Card backs are represented by graphics symbols
Lines 480-620	Play Game Uses keys to move cursor, and select card. I-up; M-down; J-left; K-right; R-reveal.
Lines 630-780	Player's turn
Lines 790-870	Pair match
Lines 880-970	No match
Lines 990-1130	Scan keyboard for input
Lines 1140-1370	Move cursor
Lines 1380-1500	Turns over card
Lines 1510-1680	Calculate which card to turn over
Lines 1690-1800	Input players' names
Lines 1910-1910	Prints final scores

(Pelmanism program)

```
  10 REM        ************
  20 REM        * MAIN BODY *
  30 REM        ************
  40 MODE 7
  50 CLS
  60 PROCSETUP
  70 PROCNAME
  80 PROCGAME
  90 PROCRESULT
 100 *FX 4,0
 110 END
 120 DEF PROCSETUP
 130 REM     ***************
 140 REM     * SET UP PACK *
 150 REM     ***************
 160 CARD=STRING$(4,"A234567890TJQK")
 170 CARD=&3A00
 180 *CARD=CARD$
 190 REM     ****************
 200 REM     * SHUFFLE PACK *
 210 REM     ****************
 220 FOR I=1 TO 200
 230   R1=RND(51)
 240   R2=RND(51)
 250   TEMP=CARD$?R1
 260   CARD?R1=CARD?R2
 270   CARD?R2=TEMP
 280   NEXT I
 290 REM     ****************
 300 REM     * DISPLAY DECK *
 310 REM     ****************
 320 VDU 12
 330 DS1$=" 9"+STRING$(6," 9")
 340 DS2$="9"+STRING$(7," 9")
 350 BORDER$=STRING$(31,".")
 360 PRINT CHR$(145)+" "+CHR$(60)+BORDER$+CHR$(108)
 370 FOR I=1 TO 3
 380   PRINTCHR$(145)+" "+CHR$(53)+SPC(31)+CHR$(106)
 390   PRINTCHR$(145)+" "+CHR$(53)+" "+DS1$+"  "+CHR$(106)
 400   PRINTCHR$(145)+" "+CHR$(53)+SPC(31)+CHR$(106)
 410 PRINTCHR$(145)+" "+CHR$(53)+" "+DS2$+" "+CHR$(106)
 420   NEXT
 430 PRINTCHR$(145)+" "+CHR$(53)+SPC(31)+CHR$(106)
 440 PRINTCHR$(145)+" "+CHR$(53)+" "+DS1$+"  "+CHR$(106)
 450 PRINTCHR$(145)+" "+CHR$(53)+SPC(31)+CHR$(106)
 460 PRINTCHR$(145)+" "+CHR$(45)+BORDER$+CHR$(46)
 470 ENDPROC
 480 DEF PROCGAME
 490 REM     ****************************
 500 REM     * GAME STARTS HERE *
 510 REM     ****************************
 520 SCORE=0
 530 SCORE=0
 540 REPEAT
 550   SCORE=0
 560   PROCTURN(PLY1$)
 570   SCORE=SCORE+SCORE
 580   SCORE=0
 590   IF SCORE=SCORE ( 2& THEN PROCTURN(PLY2$)
 600   SCORE$=SCORE$+SCORE
 610   UNTIL SCORE+SCORE > 25
 620 ENDPROC
 630 DEF PROCTURN(PLY$)
 640 REM     ****************
 650 REM     * PLAYERS TURN *
 660 REM     ****************
 670 REPEAT
 680   PRINTAB(0,21)"PICK YOUR FIRST CARD "|PLY$|SPC(10)
 690   PROCMOVE
 700   CD1=CARD?REV
 710   AD1=ADDRESS
 720   PRINTAB(0,21)"PICK YOUR SECOND CARD "|PLY$|SPC(10)
 730   PROCMOVE
 740   CD2=CARD?REV
 750   AD2=ADDRESS
 760   IF CD1=CD2 THEN PROCPOINT ELSE PROCFINISH
 770   UNTIL CD1 <> CD2 OR SCORE+SCORE+SCORE> 25
 780 ENDPROC
 790 DEF PROCPOINT
 800 REM     ****************
 810 REM     * "PAIR" FOUND *
 820 REM     ****************
 830 FOR I=1 TO 2500:NEXT
 840 ?AD1=32
 850 ?AD2=32
 860 SCORE=SCORE+1
 870 ENDPROC
 880 DEF PROCFINISH
 890 REM     ************
 900 REM     * NO MATCH *
 910 REM     ************
 920 FOR I=1 TO 2500:NEXT
 930 AD1?(-1)=145
 940 ?AD1=57
 950 AD2?(-1)=145
 960 ?AD2=57
 970 ENDPROC
 980 DEF PROCMOVE
 990 REM     ****************
1000 REM     * MOVE CURSOR *
1010 REM     ****************
1020 *FX 4,1
1030 PRINTAB(4,15);
1040 FLAG=0
1050 REPEAT
1060   IN$=INKEY$(0)
1070   IF IN$="I" THEN PROCUP
1080   IF IN$="J" THEN PROCLEFT
1090   IF IN$="K" THEN PROCRIGHT
1100   IF IN$="M" THEN PROCDOWN
1110   IF IN$="R" THEN PROCREVEAL
1120   UNTIL IN$="R" AND FLAG=1
1130 ENDPROC
1140 DEF PROCUP
1150 REM     ****************
1160 REM     * MOVE CURSOR UP *
1170 REM     ****************
1180 IF VPOS > 3 THEN VDU 11:VDU 11 ELSE VDU 7
1190 ENDPROC
1200 DEF PROCDOWN
1210 REM     ******************
1220 REM     * MOVE CURSOR DOWN *
1230 REM     ******************
1240 IF VPOS < 15 THEN VDU 10:VDU 10 ELSE VDU 7
1250 ENDPROC
1260 DEF PROCLEFT
1270 REM     ******************
1280 REM     * MOVE CURSOR LEFT *
1290 REM     ******************
1300 IF POS > 4 THEN VDU 8:VDU 8 ELSE VDU 7
1310 ENDPROC
1320 DEF PROCRIGHT
1330 REM     *******************
1340 REM     * MOVE CURSOR RIGHT *
1350 REM     *******************
1360 IF POS < 32 THEN VDU 9:VDU 9 ELSE VDU 7
1370 ENDPROC
1380 DEF PROCREVEAL
1390 REM     **************
1400 REM     * REVEAL CARD *
1410 REM     **************
1420 X=POS
1430 Y=VPOS
1440 ADDRESS=HIMEM+(40*Y)+X
1450 IF ?ADDRESS <> 57 THEN ENDPROC
1460 FLAG=1
1470 IF VPOS=5 OR VPOS=9 OR VPOS=13 THEN PROCEIGHT ELSE PROCSEVEN
1480 ADDRESS?(-1)=ADDRESS?(-1)-128
1490 ?ADDRESS=CARD?REV
1500 ENDPROC
1510 DEF PROCSEVEN
1520 REM     ************
1530 REM     * FIND CARD *
1540 REM     ************
1550 Y1=INT(Y/2)
1560 X1=(X-2)/4
1570 Y2=INT(Y1/2)
1580 REV=(Y2*15)+X1)-1
1590 ENDPROC
1600 DEF PROCEIGHT
1610 REM     ************
1620 REM     * FIND CARD *
1630 REM     ************
1640 Y1=INT(Y/2)
1650 X1=X/4
1660 Y2=INT(Y1/2)-1
1670 REV=(7*(Y2*15)+X1)-1
1680 ENDPROC
1690 DEF PROCNAME
1700 REM     **************
1710 REM     * INPUT NAMES *
1720 REM     **************
1730 PRINTAB(0,21)"PLAYER 1 WHAT IS YOUR NAME "
1740 INPUT PLY1$
1750 PRINTAB(0,22)SPC(40)
1760 PRINTAB(0,21)"PLAYER 2 WHAT IS YOUR NAME "
1770 INPUT PLY2$
1780 PRINTTAB(0,22)SPC(40)
1790 PRINTAB(0,21)SPC(40)
1800 ENDPROC
1810 DEF PROCRESULT
1820 REM     *******************
1830 REM     * PRINT FINAL SCORE *
1840 REM     *******************
1850 VDU 12     ***************
1860 PRINTAB(5,5)|PLY1$|" YOU HAVE SCORED "|SCORE$
1870 PRINTAB(5,8)|PLY2$|" YOU HAVE SCORED "|SCORE$
1880 IF SCORE$ > SCORE$ THEN PRINTAB(3,13)CHR$(141)|CHR$(136)|PLY1$|CHR$(137)
|"YOU'VE WON !",TAB(3,14)|CHR$(141)|CHR$(136)|PLY1$|CHR$(137)|"YOU'VE WON !"
1890 IF SCORE$ > SCORE$ THEN PRINTAB(3,13)CHR$(141)|CHR$(136)|PLY2$|CHR$(137)
|"YOU'VE WON !",TAB(3,14)|CHR$(141)|CHR$(136)|PLY2$|CHR$(137)|"YOU'VE WON !"
1900 IF SCORE$ = SCORE$ THEN PRINTAB(3,13)CHR$(141)|CHR$(136)|"IT'S A DRAW !"
|TAB(3,14)|CHR$(141)|CHR$(136)|"IT'S A DRAW !"
1910 ENDPROC
1920 DEF PROCINSTR
1930 REM     ***************
1940 REM     * INSTRUCTIONS *
1950 REM     ***************
1960 CLS
1970 PRINTTAB(11,3)|CHR$(135)|CHR$(157)|CHR$(129)|CHR$(141)|"PELMANISM   "|CHR$
(156)
1980 PRINTTAB(11,4)|CHR$(135)|CHR$(157)|CHR$(129)|CHR$(141)|"PELMANISM   "|CHR$
(156)
1990 PRINTTAB(0,10)
2000 INPUT"DO YOU REQUIRE INSTRUCTIONS ", ANSWER$
2010 IF MID$(ANSWER$,1,1) <> "Y" THEN ENDPROC
2020 PRINTTAB(0,8)" PELMANISM is a simple card game for"" two players.The ca
rds are placed face"" down,the object is to turn up pairs"
2030 PRINTTAB(0,14)|CHR$(130)|" Each player takes it in turn to try"|CHR$(130)
|"and pick two cards which match,if they"|CHR$(130)|"are a pair then they are r
emovd from"
2040 PRINTCHR$(130)|"the pack and the successful player gets"|CHR$(130)|"anothe
r turn.""|CHR$(129)|"The winner is the player who has turned"|CHR$(129)|"over th
e greatest number of pairs at"
2050 PRINTCHR$(129)|"the end."
2060 PRINTTAB(10,24)|CHR$(131)|CHR$(136)|"Press any key to continue"
2070 A$=GET$
2080 CLS
2090 PRINTTAB(11,3)|CHR$(135)|CHR$(157)|CHR$(130)|CHR$(141)|" CONTROLS    "|CHR
$(156)
2100 PRINTTAB(11,4)|CHR$(135)|CHR$(157)|CHR$(130)|CHR$(141)|" CONTROLS    "|CHR
$(156)
2110 PRINTTAB(0,10)|CHR$(129)|" I "|CHR$(135)|"- TO GO UP"
2120 PRINTTAB(0,12)|CHR$(129)|" M "|CHR$(135)|"- TO GO DOWN"
2130 PRINTTAB(0,14)|CHR$(129)|" J "|CHR$(135)|"- TO GO RIGHT"
2140 PRINTTAB(0,16)|CHR$(129)|" K "|CHR$(135)|"- TO GO LEFT"
2150 PRINTTAB(0,18)|CHR$(129)|" R "|CHR$(135)|"- TO REVEAL THE CARD"
2160 PRINTTAB(10,24)|CHR$(131)|CHR$(136)|"Press any key to continue"
2170 A$=GET$
2180 ENDPROC
```

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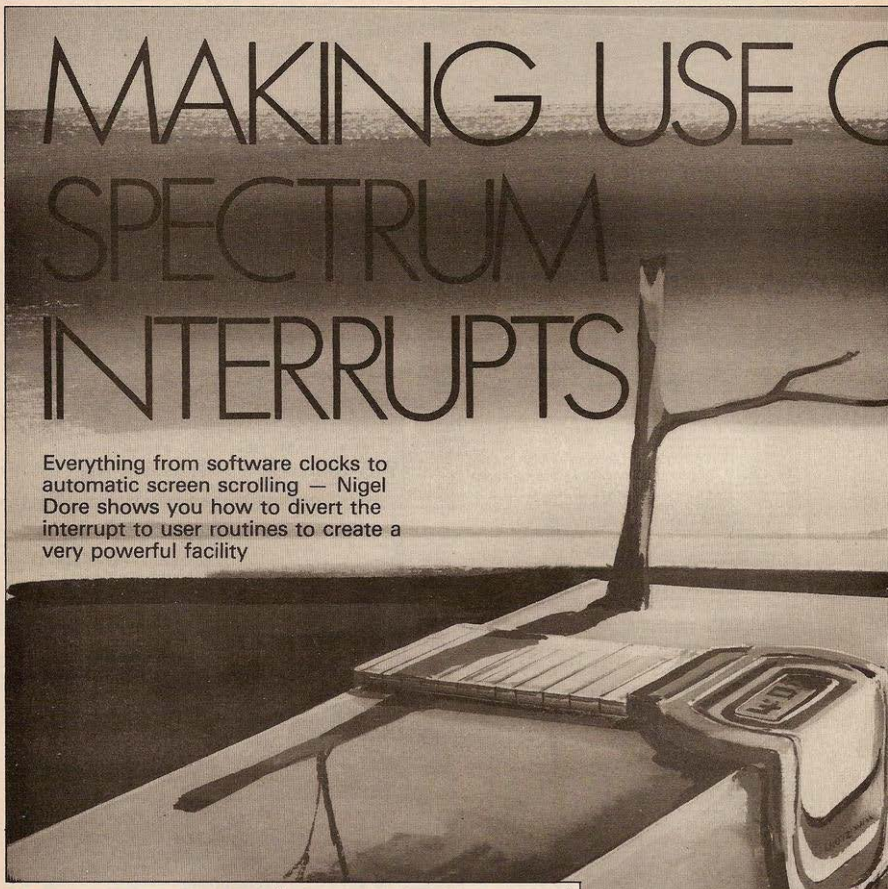


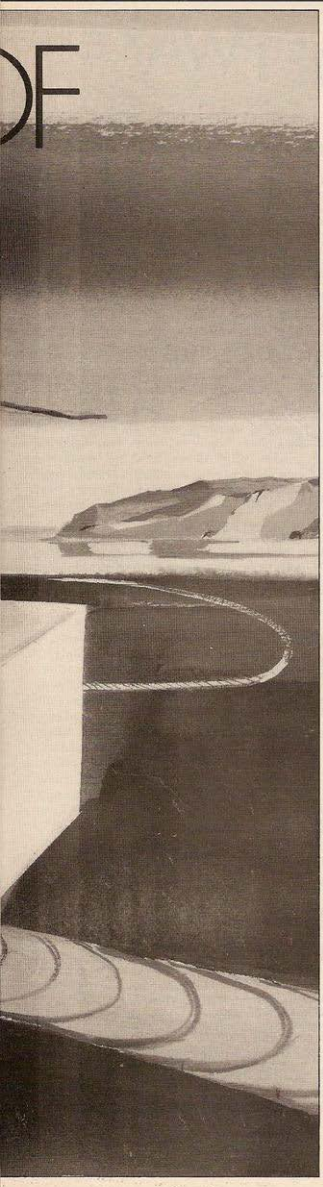
AN INTERRUPT is a signal sent to the microprocessor which generally suspends the execution of the current program — without the program knowing it.

Every 20 ms the Z-80 processor in the Spectrum receives an interrupt which forces it to suspend what it is currently doing and to jump to 38 hexadecimal or 56 decimal where it increments the system variable frames and scans the keyboard so that the Spectrum knows what you are keying in, if anything. If this interrupt could be diverted elsewhere to a user routine it would provide a very powerful facility which would have almost limitless uses. The way in which the Z-80 responds to an interrupt is governed by which interrupt mode it is operating in; the Z-80 has three modes.

Interrupt mode 0 allows the interrupting device to place one instruction on to the data-bus after the interrupt for execution by the Z-80. Interrupt mode 1 makes a jump to 38hexadecimal or 56 decimal and this is the mode that the Spectrum uses. Interrupt mode 2 is more complex. When the Z-80 receives an interrupt, it expects the interrupting device to place one byte of data on the data bus which acts as the low order of an address. The high order of the address comes from the I register. The Z-80 looks at this address which gives it a second address that it then jumps to.

The last mode provides a method of diverting the Z-80 to a user routine for, although the Spectrum does not provide the byte of data required, this means the Z-80

(continued on page 105)



16K mother program.

```
  10 REM Spectrum Interupts
  20 REM for 16k Spectrum
  30 REM @N.DORE
  35 CLEAR 32529: LET c=0
  40 FOR i=32330 TO 1e9: READ a:
 IF a<256 THEN LET c=c+a: POKE i
,ABS a: NEXT i
  70 IF a<>c THEN PRINT "ERROR I
N PROGRAM": STOP
 100 REM ON/OFF routines
 110 DATA 62,40,237,71,237,94,20
1,0,0,0,62,62,237,86,237,71,201,
0
 120 REM SERVICE ROUTINE
 130 DATA 255,243,197,213,229,24
5,1,254,127,237,120,254,252,40,9
,205,144,126,241,225,209,193,251
,201,62,56,50,141,92,205,107,13,
1,254,127,237,120,254,252,40,247
,251,207,20,0,0,0,0,0,0,0,0
 140 REM User routine(here RET)
 150 DATA 201,9306
```

16K mother program Z-80 code.

```
ON ROUTINE
ld a,40                 62 40
ld i,a                  237 71
im 2                    237 94
ret                     201
OFF ROUTINE
ld a,62                 62 62
im 1                    237 86
ld i,a                  237 71
ret                     201
SERVICE ROUTINE
rst 56                  255
di                      243
push bc                 197
push de                 213
push hl                 229
push af                 245
ld bc,32766             1 254 127
in a,(c)                237 120
cp 252                  254 252
jr z,+9                 40 9
call 32400              205 107 13
pop af                  241
pop hl                  225
pop de                  209
pop bc                  193
ei                      251
ret                     201
ld a,56                 62 56
ld (23693),a            50 141 92
call cls(3435)          205 107 13
ld bc,32766             1 254 127
in a,(c)                237 120
cp 252                  254 252
jr z,-9                 40 247
ei                      251
rst 8(reports)          207
error break             20
```

Figure 5 This generates a moving landscape at the bottom of the screen which can be used in one of your own games. The speed at which the ground moves can be changed by Poking 23681 which should be followed by Poke 23672,0. This program should be saved before being run.

```
 140>REM moving land data
 150 DATA 58,120,92,33,129,92,70
,184,216,62,0,50,120,92,33,96,90
,6,160,126,254,0,32,7,54,56,43,5
```

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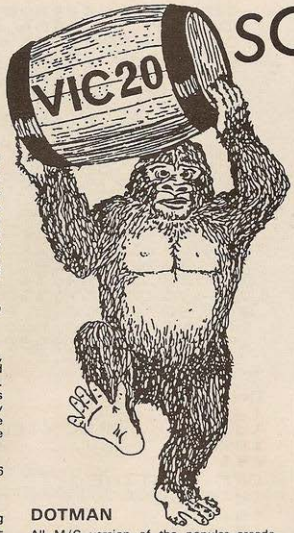

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(continued from page 102)

thinks it sees FFh or 255 decimal. Thus we need only change that I register so that the address

I*256 + 255

and the following one point to our user routine. However, the I register cannot be moved so that

I*256

is in RAM without causing screen interference.

Therefore we must find our vector address somewhere in ROM. A quick search finds suitable vectors for both 16K and 48K machines:

I = 40

will produce a jump to 32348 for 16K machines,

I = 9

will produce a jump to 65129 for 48K machines. In order to see what can be done with these interrupts first type in the mother program for your particular machine which allows all the following programs to be compatible between both machines. After typing in the program, Run it. If after a few seconds, an "Error in program" message appears, then carefully check the Data statements and try again. If "OK" appears then save the program as the checksum does not detect all possible errors. Here are the commands for turning the routine on or off:

ON
16K LET a=USR 32330
48K LET a=USR 65180
OFF
16K LET a=USR 32340
48K LET a=USR 65190

Turn the routine on. If the computer crashes, then re-load the program and check it carefully. If "OK" appears on the screen then the routine should be working. The mother program on its own adds one useful feature: the depression of symbol-shift and space together now acts as Break but with these added advantages. The new Break works in machine-code loops, it clears the screen and returns the colours to the normal black on white. The use of this break when not running a program causes a buzz with Colour Reset and Clear Screen.

To see what the routine can do, turn it off and add the lines in figure 1 erasing the original lines of the same line number. Make sure you have turned the routine off and Run the new program. Turn the routine back on and you will be greeted by a pulsating border display and a clicking sound which continues while your own programs are running.

You might like to try loading a Basic program off a cassette. The border display will stop during the load, as it will during Beep, for the computer disables the interrupts because timing is important. The border will start pulsating again as soon as the program has loaded. This program achieves its effect by outputting the contents of the frame counter to the port which controls the border 50 times a second.

The other five examples can be entered in the same way but remember to take great care that the old routine is turned off before running the mother program to enter the new routine. ■

```
4,0,35,0,35,16,241,42,121,92,35,
34,121,92,38,1,70,56,176,92,254,
1,40,23,58,177,92,203,64,40,4,60
,50,177,92,254,5,32,29,62,1,50,1
76,92,24,22,0,56,177,92,205,64,4
0,4,61
 160 DATA 50,177,92,254,1,32,6,6
2,2,50,176,92,0,58,177,92,71,17,
32,0,33,255,90,54,0,183,237,82,1
6,249,71,62,6,144,71,54,56,183,2
37,82,16,249,201,19586
 200 POKE 23728,1: POKE 23729,2:
 POKE 23681,1:
```

48K Mother program

```
  10 REM Spectrum Interupts
  20 REM for 48k Spectrum
  30 REM ©N.DORE
  35 CLEAR 64911. LET c=0
  40 FOR i=65129 TO 1e9: READ a:
 IF a=256 THEN LET i=64912: NEXT
 i
  50 IF a<256 THEN LET c=c+a: PO
KE i,ABS a+(a<0)*127: NEXT i
  70 IF a+96<>c THEN PRINT "ERRO
R IN PROGRAM": STOP
 100 REM SERVICE ROUTINE
 110 DATA 255,243,197,213,229,24
5,1,254,127,237,120,254,252,40,9
,206,144,253,241,225,203,193,251
,201,62,56,50,141,92,205,107,13,
1,254,127,237,120,254,252,40,247
,251,207,20,0,0,0,0,0,0,0
 120 REM ON/OFF routines
 130 DATA 62,9,237,71,237,94,201
,0,0,0,62,62,237,86,237,71,201,2
56
 140 REM User routine(here RET)
 150 DATA 201,9306
```

Figure 1.

```
 140>REM border display
 150 DATA 58,120,92,211,254,201,
10041
```

Figure 2 This shows you how your Spectrum can generate sounds while you enter or run a program.

```
 140>REM sound
 150 DATA 42,120,92,203,61,38,0,
41,41,41,41,17,2,0,205,181,3,201
,10434
```

Figure 3 This makes the screen scroll automatically unless the n key is pressed.

```
 140>REM Non-stop scroll
 150 DATA 1,254,127,237,120,254,
247,200,62,5,50,140,92,201,11095
```

Figure 4 This provides an On Error Beep function. It causes the computer to beep when an error occurs until Enter is pressed.

```
 140>REM On error bleep
 150 DATA 58,58,92,254,255,200,1
7,150,0,33,100,0,205,181,3,243,2
01,11155
```

Figure 6 This last routine generates a display of the 24-hour clock at the top right of the screen. The computer will even beep on the hour, all while your own program runs. Save this program before running it.

```
 140>REM clock data
 150 DATA 58,73,-127,50,121,92,[illegible]
[illegible],120,92,254,5,32,78,58,[illegible]
,92,33,82,-127,14,0,54,1,43,126
254,32,40,250,60,12,119,62,3,1[illegible]
,40,13,62,5,185,40,8,126,254,11
40,230,24,7,0
 160 DATA 126,254,7,40,222,0,3[illegible]
72,-127,126,254,3,32,14,35,126
54,5,32,8,43,6,2,54,1,35,16,251
58,121,92,87,58,73,-127,186,196
55,-127
 170 DATA 17,21,64,33,71,-127,3[illegible]
,229,213,126,71,254,32,40,22,17
8,0,33,120,61,25,16,253,209,213
6,8,126,235,119,235,20,35,16,24[illegible]
,0,209,19,225,62,31,187,32,217
 175 DATA 33,21,88,6,10,54,120,[illegible]
5,16,251,62,127,50,20,88,50,23,8
8,50,29,88,50,31,88,50,26,88,201
,0,0,0,17,128,0,33,0,1,205,181,3
,243,201,22160
 176 REM >The next line contains
[illegible]
 180 DIM a$(10): INPUT "Hour ";h
,"Minutes ";m: LET a$=("0" AND L
EN STR$ h=1)+STR$ h+"0"+("0" AND
 LEN STR$ m=1)+STR$ m+"00000": F
OR i=1 TO 10: POKE i+32563+(PEEK
 23733>130)*32512,CODE a$(i)-47
 NEXT i
 190 INPUT "Key to start",a$: PO
KE 23672,0: LET a=USR ((PEEK 237
33<130)*32330+(PEEK 23733>130)*6
5180)
```

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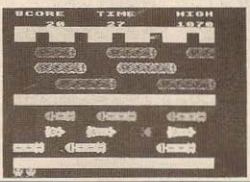

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VOICES OF THE VIC

While the Vic-20's four-channel sound facility is one of its most appealing features, do you really know how to make the most of them? John Ransley explores the electronic quartet's potential.

YOUR UNEXPANDED Vic-20 can make you feel like Richard Clayderman, Acker Bilk, John Williams or James Galway. But the big question often asked by Vic owners is, how? After all, my copy of Commodore's introductory manual manages to transpose whole chunks of instructions in that section briefly describing the micro's music-making capabilities — so anyone else attempting to exploit them might be forgiven for taking a powder and going for a long lie-down in a quiet darkened room.

So start again — from here, with some easy routines which I will explain as we go along. Incidentally, if your micro is not a Vic-20, you will find that it is still possible to foster many of these programs, usually by simply substituting for any Poke statements the equivalent Basic command in your micro's dialect, which will probably be something like Sound or Beep.

You can make creative use of at least three of the Vic's four sound generators, individually or collectively, and in several different ways. First, you can use them to play the Vic's keyboard like that of a piano or organ; secondly, the Vic can be a musician, playing itself the music you give it to learn, just as though it was an electronic pianola; thirdly, it can help you compose your own music by combining the two facilities just mentioned; fourth, the Vic can take over the actual composing and produce sonorous fugues or perky rags — and in all the programs that follow, I have incorporated some kind of screen display to help you understand even better what's going on in the Vic's mind.

The Vic's soundmakers slumber silently in four separate Poke locations: 36874, 36875, 36876 and 36877. The first three of these are always used, alone or collectively, to play music. The fourth, 36877, is the white noise generator — all of whose tones sound like nothing so interesting as an untuned radio until you start shaping them.

Of the three music voices, it is convenient to think of 36874 as being the lowest or bass voice; 36875 as the mid-range or tenor voice; and 36876 as the highest, or soprano. Each of these three voices has a library of 126 tones numbered 128 to 254 inclusive, covering some three octaves of the conventional music scale. Poke 36874 drops an octave lower than, and Poke 36876 an octave higher than, Poke 36875. Therefore, you have something like a five-octave range across the three voices.

The only other Poke location you will need is 36878, which is qualified by a number from 0 to 15. This command switches on the volume control and sets the sound level. You may find that the highest setting distorts when played through the speaker of your particular TV or monitor; Poke 36878,10 or Poke 36878,12 should be about right most times.

Type New, hit Return, and enter Program 1. Run this, and you hear each of the 127 tones held in the Vic's bass voice, and see its number displayed on-screen. Everything stops at 254 except the noise. Hit Run, Stop and Restore, then List Program 1. Tone 254 continued because I did not include a line cancelling the volume. So add these lines:

```
170 POKE 36878,0
180 POKE 36874,0
```

It is not strictly necessary to include line 180 in this program, but if you do not the old voice will stay live and still be heard behind any other voice Poked.

Each of the three Poke locations is capable of generating 126 notes. Change line 130 in Program 1 to Poke 36875,T and Run; and then to Poke 36876,T and Run to hear the tenor and soprano equivalents respectively. With these, the two or three uppermost tones are at such a high frequency that you may not even be able to hear them.

At this stage, it is important to draw a distinction between tones and notes, because only 25 of the tones in each Poke location are more or less equivalent to the notes ABCDEFG of the conventional musical scale. And to complicate matters, they match up in uneven steps. For example, note E is tone 206, F is 209 and F# is 211. The whole range of 126 available tones thereefore gives you just three octaves, from a low C on tone 131 to a high C on tone 224.

This next simple program proves the Vic's ability to produce an orderly musical scale of eight notes — C major. New the memory and enter Program 2. In this program, lines 110 to 130 set up a store cupboard of tones equivalent to the scale of C major and their names; count up the pairs and you will find they total eight in number. Lines 140 and 160 form a loop that makes line 150 read through each Data pair and store them in memory as matched sets tagged 1 to 8.

At line 170, the Vic is waiting for you to tell it which pair you want brought up front, by touching any one of the keys numbered 1 to 8 on the top row of the keyboard; the second half of line 170 makes the Vic go round in circles until you do so.

Line 180 takes the value of the key you have touched and marries it up with the Data pair tagged with that same number. So if you hit key 4, the fourth pair along in the Data queue — which happens to be 232,F — gets yanked out and put to work. On goes the volume in line 190, and line 200 selects the tenor voice and drops in the (N)ote line 180 produced. The other half of the pair, the actual letter C,

(continued on next page)

(continued from previous page)

then neatly drops into the Print statement in 210. So as you touch each key, you will hear a note in C major ranging from the lowest (triggered by key 1) to the highest (key 8), and receive visual confirmation of the note the Vic played. If you want to temporarily mute the sound, touch the space bar — or indeed, any key other than 1 to 8.

You can give yourself a little more self-tuition in equating the Vic's tone numbers with actual note values by expanding a little on the Data items. Just as an experiment, retype line 110 of Program 2 as follows:

```
110 DATA 225,C (225), 228,D (228), 231,E (231)
```

Run this revised version and when you hit key 1, 2 or 3 the screen will display not only the note name as before but also, in brackets, the tone number used to produce that note. This can be a useful aid when you are compiling Data statements from sheet music.

Before moving on to programmed music, using Data statements as scores on which the Vic can work, let us try brightening up the general sound produced by Program 2. Program 3 will teach you a new technique for shaping the character of the Vic's voices, as well as producing a new tune.

As you are now entering the realm of longer and more complicated Data queues, perhaps it is worth mentioning the most common reasons why the Vic flashes up the dreaded Out of Data error message. One is that you have missed out a comma somewhere; there must be one after every Data item except the last in any one Data line. Another is that you have typed a letter O instead of the special slashed zero, 0. Out of Data will also show up if the number given in the Read loop does not match the number of items in Data.

Finally, if you are adapting any of these routines to use in a more ambitious program, remember that you may have to set up a Dim statement to reserve memory for the Read array. If you do not, you may prompt the Bad Subscript error message.

Back to the music. Again, New the memory, and carefully type in Program 3. This sounds a little more like a piano, thanks to lines 170 to 200. These ensure that the volume of each note is heard at full volume and then dies away to nothing after the time allowed to play the (L)ength of the note in line 190. If you would like to prove to yourself that this is really happening, just add this one line to the program:

```
205 PRINT " [CLR SCR] " N; D; L
```

If all is well, the screen will display a different tone number for each note that is played, then the digit 0 and the number 31. Check through the logic of Program 3 and you should be able to understand why.

This exercise also introduces a couple of other little tricks. First, perhaps you noticed the dummy value of 0 at the end of line 120. That is because, unlike Program 2, the Read statement in line 140 simply starts at the first item of Data and doggedly works its way right through the queue, item by item. The 0 signals to the second part of line 140 that the notes are all used up and so the tune is over. Without it, the program would jam on the last note and flip up the news Out of Data Error in

(continued on page 111)

Program 1.

```
100 REM PROGRAM 1
110 POKE 36878,10
120 FOR T=128 TO 254
130 POKE 36874,T
140 PRINT T,
150 FOR D=1 TO 400
160 NEXT D:NEXT T
```

Program 2.

```
100 REM PROGRAM 2
110 DATA 225,C,228,D,
    231,E
120 DATA 232,F,235,G,
    237,A
130 DATA 239,B,240,C
140 FOR N=1 TO 8
150 READ S(N), N$(N)
160 NEXT N
170 GET K$:IF K$=""
    THEN 170
180 N=VAL(K$)
190 POKE 36878,10
200 POKE 36875, S(N)
210 PRINT"[CLR SCR]
    YOU HIT NOTE ";N$(N)
220 GOTO 170
```

Program 4.

```
100 REM PROGRAM 4
110 DATA 215,400,217,
    600,215,400,209,
    600,207,400,209,
    600
120 DATA 215,400,221,
    600,217,400,215,
    600,209,400,217,
    600
130 RESTORE
140 READ N:IF N=0
    THEN220,0
150 READ D
160 POKE 36875,N
170 POKE 36878,10
180 FOR L=1 TO
    D:NEXT L
190 POKE 36878,0
200 GOTO 140
210 POKE 36874,
    0:POKE36878,0
220 END
```

Program 7.

```
100 REM PROGRAM 7
110 N=INT(RND(1)
    *30)+195
120 POKE 36878,10
130 POKE 36875,N
140 PRINT"I'M PLAYING
    TONE";N
150 FOR D=1TO400:
    NEXT D
160 POKE 36878,0
170 GOTO 110
```

Program 6.

```
100 REM PROGRAM 6
110 N=INT(RND(1)
    *129)+126
120 POKE 36878,10
130 POKE 36875,N
140 PRINT"I'M PLAYING
    TONE";N
150 FOR D=1TO400:
    NEXT D
160 POKE 36878,0
170 GOTO 110
```

Program 5.

```
100 REM PROGRAM 5
110 DATA 201,800,209,400,225,1200,221,
    800,209,400,203,1200
120 DATA 201,800,201,400,201,400,203,
    400,209,400,215,1200,209,1200
130 DATA 201,800,209,400,225,1200,221
    ,800,209,400,203,1200
140 DATA 201,800,209,400,209,400,215,
    400,219,400,221,1200,221,1200,5
150 RESTORE
160 READ N:IF N=5 THEN 220
170 READ V
180 POKE 36878,10:POKE36876,N
190 FOR D=1 TO V:NEXTD
210 GOTO 160
220 POKE 36876,0:POKE 36878,0
230 END
```

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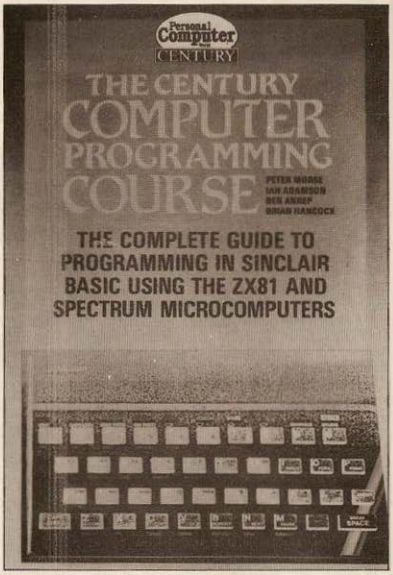

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(continued from page 108)

140. If you like, try this for yourself by cursoring out the dummy zero and then Running the program.

Secondly, the Restore statement in line 130 is not strictly necessary in this particular program as you have to rerun it every time you want to hear the music anyway. But usually, you will want to set Read's pointer to the head of the Data queue in line 110 in case you want to call it again; Restore does just that.

Before we go on to refine Program 3 by giving each of the notes proper values, do not overlook the creativity which lines 170 to 200 offer you. You can tinker with these along with lines 150 and 160 to get a sound more like a bar-room piano than a Bechstein, for example. Lower the 15 to 0 range of line 170 and you will soften the apparent attack; alter the Step value in the same line — even to a decimal such as .25 — and you can remould the sustain and rate of decay.

You could try adding 36876 as well, or trying different combinations of the three. Further, changing the value of the delay loop in line 190 alters the overall speed at which all this happens. This little suite of three variables is one of the most powerful tools you have in exploiting the Vic's soundmaking potential.

So Program 3 opened some new horizons, but to hear the music played properly, we need to pair every note in the Data queue with a value representing its proper duration, just as we added the letters of the scale in Program 2.

Tidy the Vic's memory by typing New and hitting Return, and this time we will have James Galway audition for Dooley Wilson's job at the Café Américain in program 4.

The deliberate error is at line 190. That Poke is chopping up the notes in a way that a flautist certainly does not do. So delete line 190 altogether and Run the program again. Now the notes do glide into one another as they should.

In this exercise I have used a value of 3,000 to the bar. It is an easy matter to quicken or slow the overall tempo at which this or any other tune is played, by simply changing proportionally the value given to each D item in Data. Thus you could accelerate Mr Galway by changing 400s to 300s, and the 600s to 450s, and so on.

But beware, this deceptively easy program has a trap for the unwary. New memory and enter Program 5.

When you Run this program, all will be well until you hear the Vic play those notes in lines 120 and 140 which are the same in tone, if not duration, of those preceding them. Just drop in a pair of zeros to achieve an imperceptible break. You may use this same trick to imitate the rests shown on sheet music. You can specify the length of the rest by giving N a proper value to work on. As an example:

```
DATA 201,400,0,200,201,400
```

will sound tone 201 for, say, a half-note; then introduce a quarter-note rest; and then play 201 for another half-note. You may also have noticed that the end of data signals at the end of lines 140 and 160 were changed to 5 from the usual 0, so that when you correct this program by adding double zeros to lines 120 and 140, your program will not end prematurely. You can go on qualifying Data lines with yet more items, provided that they are always in logical sets.

You might, for example, have the notes and durations for a melody line as elements one and two in a four item set; with a bass line and associated note durations or rests as the third and fourth elements. This way you can achieve a very effective syncopated or walking bass rhythm. For a demonstration of this technique, I can do no better than refer you to Adam Macielinski's ingenious boogie programs in the March 1983 issue of *Your Computer*. Adding the Vic's third voice will give you three-part harmony in a carefully structured Data queue comprising six-element items; and maybe now is the time to experiment more with Poke 36877 to drop in a snare drum.

After all that your fingers could do with a rest, so why not let the Vic get on with some composing of its own. Program 6 generates a random number between 128 and 254, which becomes the tone qualifier for line 130; and line 140 prints it out for you. The tone plays for a time set by the loop in 150 and the program then loops back for its next randomiser to give a continuous demonstration of *musique silicon* if not *concrète*.

The snag is that line 110 draws from too wide a choice of tones, many of which do not equate to real musical notes anyway. You can improve matters a little by reducing the choice for N to, say, just one middle octave. Make this alteration:

```
100 REM PROGRAM 7
110 N + INT(RND(1)*30) + 195.
```

Better, but you are still hearing some bum notes that make it sound rather strange. The best solution comes with our old friend the Data statement. New memory and enter Program 8.

Here, lines 110, 120 and 130 set up a single octave of C major while 150 generates at random a number between 1 and 8; line 160 puts this on-screen. The volume is set in line 170, and 180 delves into the Data queue at that position fixed by R. Line 200 gives a moment of silence before looping back for the next cycle.

This program will generate music that sounds more "true" — now it is just plain monotonous thanks to line 190 sounding each note for precisely the same length of time. But it is an easy matter to introduce a further randomiser which will select different note values — the length and relationship of which you can fix. Revise the last program by changing it as follows from line 190 onwards — see Program 9.

Not stunningly elegant but it does the job. The values at the end of lines 210 to 240 you can tinker with yourself; the lower the numbers, the faster the music.

There is very much more to music making and computerised composing on your Vic 20 — not to mention the sound effects capabilities which I have not got around to examining here in any detail. Still, I hope you have fun trying, testing and adapting the programs given here and that they will help you to develop the know-how and curiosity that can result in some really original efforts of your own — ones worth listening to, as well!

Program 8.

```
100 REM PROGRAM 8
110 PRINT"J"
120 DATA 195,201,
    207,209,215,
    219,223,225
130 FOR N=1 TO 8
140 READ S(N):NEXT N
150 R=INT(RND(1)*8)+1
160 PRINT R;
170 POKE 36878,10
180 POKE 36875,S(R)
190 FOR D=1 TO 600:
    NEXT D
200 POKE 36878,0
210 GOTO 150
```

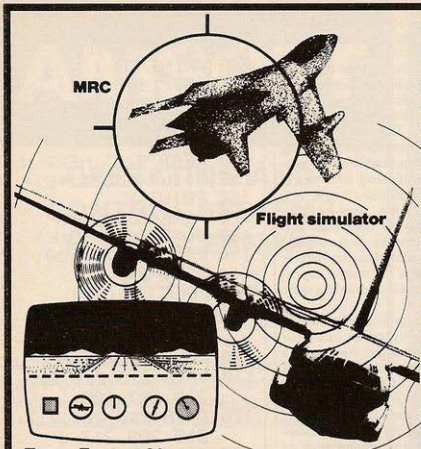
Program 3.

```
100 REM PROGRAM 3
110 DATA 215,217,215,
    209,207,209
120 DATA 215,221,217,
    215,209,217,0
130 RESTORE
140 READ N:IF N=0
    THEN220
150 POKE 36874,N
160 POKE 36875,N
170 FOR D=15 TO 1
    STEP -1
180 POKE 36878,D
190 FOR L=1 TO 30
200 NEXT L:NEXT D
210 GOTO 140
220 POKE 36874,0:POKE
    36875,0:POKE
    36878,0
230 END
```

Program 9.

```
100 REM PROGRAM 9
110 PRINT"J"
120 DATA 195,201,207,
   209,215,219,223,225
130 FOR N=1 TO 8
140 READ S(N):NEXT N
150 R=INT(RND(1)*8)+1
160 PRINT R;
170 POKE 36878,10
180 POKE 36875,S(R)
190 V=INT(RND(1)*4)+1
200 PRINT V;
210 IF V=1 THEN L=150
220 IF V=2 THEN L=250
230 IF V=3 THEN L=350
240 IF V=4 THEN L=450
250 PRINT D;
260 POKE 36878,10
270 FOR D=1 TO L:NEXT
280 POKE 36878,0
290 GOTO 150
```

■



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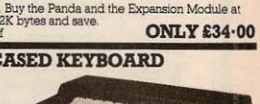

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FINE SCROLLING

ATARI

Flashing junk, nasty jerks: two of the problems that arise when using fine scrolling in Basic. Chris Lam looks at ways in which Atari users can circumvent unpleasant experiences.

WHAT IS THE difference between fine scrolling and coarse scrolling?

Coarse scrolling is where one character at a time moves. This gives a very jerky effect. Type in program 1 and Run it. The program manipulates LMS operands to implement the coarse scroll. Any method can be used: it is just that LMS manipulation is easier. The program tells Antic — the graphics processor — where to start displaying data from. It runs through addresses 0 to 65535. We will call the addresses which are Poked to tell Antic where to start displaying screen data, DList and DList+1. Try steps of 19, 20 and 21 in line 30. Change lines 20 and 30 so that they run from 255 to 0.

Just for those who do not know what LMS operands are, LMS — load memory scan — is an instruction followed by a 16-bit address. The address of the low byte is

PEEK (560) + 256*PEEK(561) + 4

Now for fine scrolling. Add program 2 to program 1. There are two built-in scroll registers HScrol — 54276 — and VScrol — 54277 — which hold the number of pixels to be scrolled. The direction of the scroll depends on the sequence of numbers we Poke into it. Before these registers can be deployed, we have to enable the lines on the screen for fine scrolling. Lines 12 and 13 do this. In line 12, the 64 is the LMS instruction, 16 is the horizontal fine scroll enabler — 32 is the vertical scroll enabler — and 7 is the Antic number for graphics 2. Number 6 is for graphics 1, and 2 is for graphics 0.

The registers can only be used to scroll up to 15 pixels either way. Therefore we must combine fine scrolling with coarse scrolling.

Line 58 is the loop which determines the direction and the extent of scroll. A "0 to limit" gives an upwards or left-to-right scroll while a "limit to 0 step-1" gives a downward or right to left scroll. Look at figure 1 to determine the value of limit.

Line 62 resets the screen to its starting position before the coarse scroll. The value to be Poked is always the first number in line 58.

(continued on next page)

Program 1.

```
5 GRAPHICS 2+16
10 DLIST=PEEK(560)+256*PEEK(561)
11 DLIST=DLIST+4
20 FOR N=0 TO 255
30 FOR M=0 TO 255
40 POKE DLIST,M
50 POKE DLIST+1,N
60 FOR DELAY=1 TO 100:NEXT DELAY
70 NEXT M:NEXT N
80 END
```

Program 2.

```
5 GRAPHICS 2+16
10 DLIST=PEEK(560)+256*PEEK(561)
11 DLIST=DLIST+4
12 POKE DLIST-1,64+16+7:REM EXTRA LINE
13 FOR N=2 TO 13:POKE DLIST+N,16+7:NEXT
   N:REM EXTRA LINE
20 FOR N=0 TO 255
30 FOR M=0 TO 255
40 POKE DLIST,M
50 POKE DLIST+1,N
58 FOR J=7 TO 0 STEP -1:REM EXTRA LINE
59 POKE 54276,J:REM EXTRA LINE
60 FOR DELAY=1 TO 100:NEXT DELAY
61 NEXT J:REM EXTRA LINE
62 POKE 54276,0:REM EXTRA LINE
70 NEXT M:NEXT N
80 END
```

Program 3.

```
5 GRAPHICS 2+16
6 D=PEEK(560)+PEEK(561)*256
10 GOSUB 100
11 ACT=USR(ADR(A$))
12 POKE D+3,64+32+16+7
13 FOR N=2 TO 13:POKE D+4+N,55:NEXT N
14 POKE D+18,65
15 POKE D+19,PEEK(560)
16 POKE D+20,PEEK(561)
18 POKE 1536,15
```

(listing continued on next page)

(continued from previous page)
Before going on, see if you can convert the program to do a vertical fine scroll downwards.

Two problems arise with using fine scrolling on Basic. First is the flashing junk. Second is the unpleasant jerks. Both can be cured by changing scroll registers and LMS operands during the time which the screen is blank.

Type in program 3. The routine is enclosed in lines 101 onwards. This routine is executed fifty times a second exactly. You have to feed the routine with information.

POKE 203, number of pixels to scroll horizontally.
POKE 204, number of pixels to scroll vertically.
POKE 205, low byte of new start of screen RAM.
POKE 206, high byte of new start of screen RAM.
POKE 207, low byte of DLIST.
POKE 208, high byte of DLIST.
POKE 209, if Poked with a non-zero number it will load the LMS operands with what is in location 205, 206.
POKE 1536, number you would normally have on line 73 of program 2. This is the horizontal one.
POKE 1537, number you would normally have in line 73 of program 2. This is the vertical one.

This routine caters for horizontal and vertical scrolling. Program 3 demonstrates diagonal scrolling. Use this routine in your programs. You are probably saying to yourself "Who wants to watch a load of scrolling junk?". If you set up a string and manipulate LMS operands to point to the start of the string, then changing the contents of the string, we can implement coarse scroll. Try program 4.

The last program gives the skeleton on which the scrolling map in Eastern Front 1941 is created. Use your joystick to scroll the screen over nine screens full of random characters. A final warning. The computer has an internal character set which is not the same as the standard one. Such maps require a lot of careful planning before they can be created. This is all possible because screen data is not fixed to one section of memory but can be anywhere. Imagine how difficult it would be if you had to move all the data through screen ram. Program 5 uses twelve LMS instructions which is the proper set up for horizontal scrolling.

Why not try replacing MAP$ with your own graphics? ■

Figure 1.

Graphics mode	0	1	2	3	4	5
Horizontal 1 unit	3	7	7	3	1	1
Vertical 1 unit	7	7	15	7	3	3

```
19 POKE 1537,15
20 FOR I=255 TO 0 STEP -1
40 FOR J=255 TO 0 STEP -22
42 POKE 205,J:POKE 206,I:POKE 209,1
50 FOR N=15 TO 0 STEP -1
57 POKE 204,N
58 POKE 203,N
59 FOR K=0 TO 20:NEXT K
60 NEXT N
70 NEXT J
80 NEXT I
90 STOP
100 REM DATA
101 DATA 165,209,240,25,160,0,165,205,145,207,
    200,165,206,145,207,173,0,6,133,203
102 DATA 173,1,6,133,204,169,0,133,209,165,203,
    141,4,212,165,204,141,5,212
109 DATA 76,98,228
110 FOR N=0 TO 41:READ A:POKE 1538+N,A:NEXT N
120 DATA 160,2,162,6,169,7,32,92,228,104,96
130 DIM A$(11)
140 FOR N=1 TO 11:READ A:A$(N,N)=CHR$(A):NEXT N
150 CO=D+4
160 POKE 208,INT(CO/256)
165 POKE 207,CO-INT(CO/256)*256
170 RETURN
```

Program 4

```
5 GRAPHICS 2+16
10 DIM SCR$(240),LINE$(7)
15 SCR$(1)=" ":SCR$(240)=" ":SCR$(2)=SCR$
16 REM IN 15 PUT CTRL J BETWEEN QUOTES
20 LINE$="          "
25 REM 20 IS CTRL J,,,,,J
30 START=ADR(SCR$)
31 DLIST=PEEK(560)+256*PEEK(561)+4
32 HI=INT(START/256)
33 POKE DLIST+1,HI
34 POKE DLIST,START-HI*256
40 SVE=IN
50 RAND=INT(RND(0)*2+1)
60 IN=IN+(RAND=1)-(RAND=2)
70 IF IN=-1 OR IN=14 THEN IN=SVE
75 SCR$(1,220)=SCR$(21,240)
80 SCR$(221+IN,221+IN+6)=LINE$
90 FOR N=1 TO 50:NEXT N
110 GOTO 40
```

Program 5.

```
3 GRAPHICS 0:POSITION 15,12:?
  "PLEASE WAIT"
4 GOTO 10
5 FOR F=1 TO 60:B$(F,F)=CHR$
  (PEEK(53770)):NEXT F:RETURN
10 DIM MAP$(2160),B$(60)
20 FOR N=1 TO 2101 STEP 60
40 GOSUB 5:MAP$(N,N+59)=B$
70 NEXT N
90 BEGIN=ADR(MAP$)
100 GRAPHICS 2+16:ST=1536
120 FOR N=0 TO 2:POKE ST+N,112:NEXT N
130 FOR I=1 TO 12
140 POKE ST+3*I,71
150 MEMST=BEGIN+(I-1)*60
155 HI=INT(MEMST/256)
160 POKE ST+3*I+2,HI
170 POKE ST+3*I+1,MEMST-HI*256
180 NEXT I
190 POKE 1575,65
200 POKE 1576,0
210 POKE 1577,6
220 POKE 560,0
230 POKE 561,6
1000 X=0:Y=0
1005 POKE 712,10
1010 ST=STICK(0)
1020 IF ST=15 THEN 1010
1030 X=X+(ST=7 AND X<40)-
     (ST=11 AND X>0)
1040 Y=Y-(ST=14 AND Y>0)+
     (ST=13 AND Y<24)
1050 TMP=BEGIN+X+Y*60
1060 FOR N=1540 TO 1573 STEP 3
1070 HI=INT(TMP/256)
1075 POKE N+1,HI
1080 POKE N,TMP-HI*256
1090 TMP=TMP+60
1100 NEXT N
1110 GOTO 1010
```

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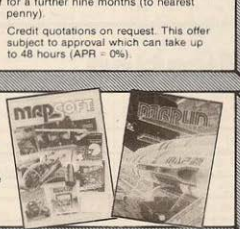

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Two excellent new machines have just been added to our coverage – the Commodore 64 and the Oric. Software for these machines will be in our next Newsletter. Remember, membership is completely free of charge and you are under no obligation to buy anything from the Club unless you really want to. If you use a ZX81 (16k), Spectrum (16k or 48k), BBC (A or B), Dragon 32, Vic (expanded or unexpanded), Commodore 64 or Oric, you should join THE CLUB.

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MONITOR AND DISASSEMBLER

These versatile routines written by Brian Cadge for the Dragon 32 provide you with a monitor which is ready for instant use whilst being invisible to the Basic user.

THIS MACHINE-CODE monitor for the Dragon 32 computer offers nine commands directly accessible from the keyboard in Basic. Once installed, the monitor is called by pressing the right arrow key; this is achieved by interrupting the Dragon's key-scan routine to check whether the right arrow has been pressed. In this way the monitor can be ready for use at any time whilst being transparent to the Basic user.

When you call the monitor by pressing the right arrow key, you should get the monitor's command prompt. This is a left-pointing arrow and means that Monit32 is expecting a command. There are two other important prompts which you will need to know, these are: the "greater-than sign" which means Monit32 requires a 16-bit — four digit hexadecimal — address or length. All numbers input and output in hexadecimal. It is important to enter four characters, for example if the number 7F3 were to be entered you must type 07F3.

The other prompt is a "less-than sign" which means that Monit32 is expecting an eight-bit — two-digit hex — number. Here is a summary of the commands and their uses:

- O Sets the origin address which is used by some of the other commands.
- A Allows you to enter code into memory starting at the address set by O. To terminate the command enter an asterisk as the code.
- E Displays the contents of a page of memory in hexadecimal starting from the address set by O. Pressing Enter will increase the address by one, pressing Clear will decrease the address by one. Pressing the space-bar returns to command level.
- F This command is used to fill a section of memory with a constant. When pressed, Monit32 will first require a 16-bit length and then the value of the constant. That length of memory will then be filled with that constant starting at the address set by O.
- J This is used to jump to the 16-bit address given after J.
- M The M command is very useful for moving machine-code or graphics pages. When called, the monitor first requires the length of code to be moved, for example, 00FE to move 254 bytes. Then the starting address of the destination is entered. The code starting at the address set by 0 will then be copied to the memory starting at the address given for the length given.
- R The contents of the 6809E microprocessor registers, A, B, X, Y, S and U

(continued on next page)

Disassembled version of the monitor.

```
10 CLEAR 200,31699
15 T=0:PRINT:PRINT"PLEASE WAIT A MOMENT WHILST CODEIS INSTALLED...":SOUND190,1
20 FOR I=1 TO 59:READ A$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
21 IF T<>5885 THEN PRINT"DATA ERROR IN 30":STOP
30 DATA 81,09,27,1,39,34,36,86,39,B7,01,6A,9E,88,86,5F,A7,89,0,0,30,1,9F,88,BD,A
0,EA,B7,7F,EE,8A,40,9E,88,A7,89,0,0,30,1,9F,88,B6,7F,EE,01,5A,26,08,86,7E,B7,01,
6A,35,36,39,20,3B
50 'return value in buff+X in B
60 FOR I=60 TO 118:READ A$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
61 IF T<>13250 THEN PRINT"DATA ERROR IN 70":STOP
70 DATA A6,89,7F,EE,80,39,2E,0B,A6,89,7F,EE,80,30,C6,10,3D,20,08,A6,89,7F,EE,80,
37,20,F3,A6,89,7F,EF,80,39,2E,0F,A6,89,7F,EF,80,30,12,B7,7F,F2,FB,7F,F2,20,08,A6
,89,7F,EF,80,37,20,EF,39
90 'input routine for buff1-4
100 FOR I=119 TO 183:READA$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
101 IF T<>19267 THEN PRINT"DATA ERROR IN 110":STOP
110 DATA 7E,7D,E9,8E,0,0,BD,A0,EA,81,08,26,11,0C,0,0,27,F4,10,9E,88,31,3F,10,9F,
88,30,1F,20,E8,81,0D,26,04,BD,90,A1,39,A7,89,7F,EE,8A,40,8C,00,04,24,0E,30,01,10
,9E,88,A7,A9,00,00,31,21,10,9F,88,20,C5
150 'hex print routine val in B
160 FOR I=184 TO 233:READ A$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
161 IF T<>24421 THEN PRINT"DATA ERROR IN 170":STOP
170 DATA F7,7F,FF,54,54,54,54,C4,0F,C1,09,2E,04,CB,70,20,02,CB,37,8D,12,F6,7F,FF
,C4,0F,C1,09,2E,04,CB,70,20,02,CB,37,8D,01,39,9E,88,E7,89,00,00,30,01,9F,88,39
190 'recognise MONIT32 command
200 FOR I=234 TO 307:READ A$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
201 IF T<>31181 THEN PRINT"DATA ERROR IN 210":STOP
210 DATA 81,4F,26,03,7E,7E,33,81,4A,26,03,7E,7E,57,81,53,26,03,7E,7E,8A,81,45,26
,3,7E,7E,95,81,46,26,03,7E,7F,1E,81,4D,26,03,7E,7F,66,81,52,26,03,7E,7C,3B,81,41
,26,03,7E,7B,D4,9E,88,86,7F,A7,89,0,0,30,1,9F,88,BD,90,A1,7E,7D,0C
250 'set origin module 'O'
260 FOR I=308 TO 343:READ A$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
261 IF T<>35368 THEN PRINT"DATA ERROR IN 270":STOP
270 DATA 9E,88,86,7E,A7,89,0,0,30,01,9F,88,BD,7D,79,8E,0,0,BD,7D,3B,F7,7F,FD,8E,
0,2,BD,7D,3B,F7,7F,FE,7E,7D,0C
290 'Jump to address 'J'
300 FOR I=344 TO 394:READA$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
301 IF T<>40535 THEN PRINT"DATA ERROR IN 310":STOP
310 DATA 9E,88,86,7E,A7,89,0,0,30,1,9F,88,BD,7D,79,8C,0,0,2E,3,7E,7D,8C,8E,0,0,B
D,7D,3B,F7,7E,88,8E,0,2,BD,7D,3B,F7,7E,89,86,7E,B7,01,6A,35,36,7E,83,71
```

(listing continued on next page)

(listing continued from previous page)

```
340 'exec subroutine from origin
350 FORI=395 TO 405:READA$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
351 IF T<>42167 THEN PRINT"DATA ERROR IN 360":STOP
360 DATA BD,90,A1,BE,7F,FD,A0,84,7E,7D,0C
390 'examine memory form origin
400 FOR I=406 TO 542:READ A$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
401 IF T<>59267 THEN PRINT"DATA ERROR IN 410/420":STOP
410 DATA BE,0,0,86,60,A7,89,04,00,30,01,8C,02,00,26,F5,8E,04,00,9F,88,10,BE,7F,F
D,10,BF,7F,F6,86,0E,B7,7F,F5,F6,7F,F6,BD,7D,B7,F6,7F,F7,BD,7D,B7,86,09,9E,88,30,
01,9F,88,10,BE,7F,F6,E6,A4,31,21,10,BF,7F,F6,BD,7D,B7,4A,26,E8,BD,90,A1,86,7F,F5
,4A
420 DATA 27,05,B7,7F,F5,20,CC,9E,88,86,6A,A7,84,30,1,9F,88,BD,A0,EA,81,0D,26,0A,
BE,7F,FD,30,01,BF,7F,FD,20,9F,81,0C,26,0A,BE,7F,FD,30,1F,BF,7F,FD,20,F0,81,20,26
,DD,BD,90,A1,7E,7D,0C
450 'fill form origin 'F'
460 FOR I=543 TO 614:READ A$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
461 IF T<>6768B THEN PRINT"DATA ERROR IN 470":STOP
470 DATA 86,7E,9E,88,A7,84,30,01,9F,88,BD,7D,79,8E,0,0,BD,7D,3B,F7,7F,F5,8E,00,0
2,BD,7D,3B,F7,7F,F6,9E,88,86,7C,A7,84,30,01,9F,88,BD,7D,79,8E,0,0,BD,7D,3B,BE,7F
,FD,10,BE,7F,F5,E7,84,30,01,31,3F,10,8C,0,0,26,F4,7E,7D,0C
490 'move code 'M'
500 FOR I=615 TO 714:READA$:POKE 31999+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
501 IF T<>79939 THEN PRINT"DATA ERROR IN 510/520":STOP
510 DATA 86,7E,9E,88,A7,84,30,01,9F,88,BD,7D,79,8E,0,0,BD,7D,3B,F7,7F,F5,8E,0,2,
BD,7D,3B,F7,7F,F6,86,7E,9E,88,A7,84,30,01,9F,88,BD,7D,79,8E,0,0,BD,7D,3B,F7,7F,F
7,8E,0,2,BD,7D,3B,F7,7F,F8,BE,7F,FD,10,BE,7F,F7,A6,84,A7,A4,30,01,31,21,10,BF,7F
,F7
520 DATA 10,BE,7F,F5,31,3F,10,BF,7F,F5,10,8C,0,0,26,E0,7E,7D,0C
550 'display registers 'R'
560 FOR I=1TO197:READA$:POKE 31002+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
561 IF T<>108885 THEN PRINT"DATA ERROR IN 570/580/590":STOP
570 DATA 35,36,BF,7F,EE,10,BF,7F,F0,10,FF,7F,F2,FF,7F,F4,B7,7F,F6,F7,7F,F7,34,36
,BD,90,A1,20,16,34,2,BD,90,A1,35,2,9E,88,A7,84,30,01,86,7D,A7,84,30,02,9F,88,39,
86,41,BD,E6,F6,7F,F6,BD,7D,B7,86,42,BD,DC,F6,7F,F7,BD,7D,B7,86,58,BD,D2,F6,7F,EE
,BD,7D,B7
580 DATA F6,7F,EF,BD,7D,B7,86,59,BD,C2,F6,7F,F0,BD,7D,B7,F6,7F,F1,BD,7D,B7,86,53
,BD,B2,F6,7F,F2,BD,7D,B7,F6,7F,F3,BD,7D,B7,86,55,BD,A2,F6,7F,F4,BD,7D,B7,F6,7F,F
5,BD,7D,B7,BD,90,A1,BD,90,A1,9E,88,86,50,A7,84,30,1,86,52,A7,84,30,1,86,4F,A7,84
,30,1,86
590 DATA 47,A7,84,30,2,9F,88,DC,1B,83,0,2,93,19,FD,7F,EE,F6,7F,EE,BD,7D,B7,F6,7F
,EF,BD,7D,B7,BD,90,A1,7E,7D,0C
600 'enter code into memory 'A'
610 FOR I=1 TO 103:READA$:POKE 31699+I,VAL("&H"+A$):T=T+VAL("&H"+A$):NEXT
611 IF T<>122108 THEN PRINT"DATA ERROR IN 620/630"
620 DATA BD,90,A1,9E,88,86,4F,A7,84,30,01,86,7D,A7,84,30,02,9F,88,F6,7F,FD,BD,7D
,B7,F6,7F,FE,BD,7D,B7,BD,90,A1,10,BE,7F,FD,10,BF,7F,F6,9E,88,86,7C,A7,84,30,02,9
F,88,BD,7D,79,B6,7F,EE,81,2A,26,03,7E,7D,0C,8C,0,0,26,0F,9E,88,86,7F,A7,84,30,1,
9F,88
630 DATA BD,90,A1,20,D5,8E,0,0,BD,7D,3B,BE,7F,F6,E7,84,30,1,BF,7F,F6,20,C3
700 POKE 363,125:POKE 364,0
710 POKE 362,126
720 CLS:PRINT"MONIT32 INSTALLED AND READY -  PRESS RIGHT ARROW KEY TO CALL  MO
NIT32...":SOUND190,1
730 NEW
```

Program 2.

```
5 ' RE-PROGRAM RESET BUTTON
10 CLEAR 300,31099
20 FOR I=0 TO 22:POKE 31100+I,PEEK(46159+I):NEXT
30 FOR I=23 TO 48:READA$:POKE 31100+I,VAL("&H"+A$):NEXT
40 DATA 8E,0,0,C6,01,A6,89,79,AE,A7,89,04,00,30,01,5A,26,F3,8E,04,FF,9F,88,7E,03
,71
50 CLS
60 PRINT "ENTER MESSAGE TO BE PRINTED WHENRESET BUTTON IS PRESSED (NO      INVERS
E CHARACTERS...":PRINT
70 LINE INPUT A$
80 FOR I=1 TO LEN(A$)
90 POKE 31149+I,ASC(MID$(A$,I,1))OR64
100 NEXT:POKE 31127,LEN(A$)
110 POKE 114,121:POKE 115,124
120 PRINT:PRINT"MESSAGE ENTERED... PRESS RESET  TO TEST..."
130 END
```

Program 3.

```
10 ' 6809 DIS-ASSEMBLER FOR DRAGON 32 BY BRIAN CADGE
20 ' ***********************************************
30 CLS:POKE 155,80:POKE 154,64:POKE 153,16:POKE 328,0: 'SET UP 80 COLUMN PRINTER
40 CLEAR 5000:DIM A$(255,2)
50 FOR I=0 TO 255:READ A$(I,0),A$(I,1),A$(I,2):NEXTI
60 PRINT"6809 DIS-ASSEMBLER FOR DRAGON 32"
70 PRINT:PRINT:PRINT:SOUND100,1:SOUND150,1:SOUND200,1
80 PS=PEEK(65314)AND1
90 INPUT "PRINTER [P] OR SCREEN [S] ";OP$:IF OP$<>"P" AND OP$<>"S" THEN 90 ELSE
IF OP$="P" THEN PR=-2 ELSE PR=0
100 IF PR=-2 AND PS=1 THEN PRINT"ATTEND TO PRINTER!!!":EXEC 41194:GOTO 80
110 INPUT "START ADDRESS , END ADDRESS";AD,EA
120 IF EA<0 OR EA>65535 OR EA<AD OR AD<0 OR AD>65535 THEN PRINT"INVALID ADDRESS
- REDO":GOTO70
130 CLS:PRINT@500:PRINT#PR,"":PRINT#PR,""
140 FOR I=AD TO EA
150 LI=I
160 SH=0
170 V=PEEK(I)
180 IF V=16 THEN SH=1:I=I+1:GOTO170
190 IF V=17 THEN SH=2:I=I+1:GOTO170
200 Z$=A$(V,SH):X$=RIGHT$(Z$,1)
210 IF X$<>"^" AND X$<>"@" AND X$<>"#" AND X$<>"%" AND X$<>"&" AND X$<>"<" AND X
$<>">" AND X$<>"/" THEN P$=Z$ ELSE P$=LEFT$(Z$,LEN(Z$)-1)
220 IF PR=0 THEN PRINT1,TAB(10);P$; ELSE PRINT#PR,I;P$;
230 IF X$="@" THEN 360
240 IF X$="%" THEN 380
```

(continued from previous page)

will be displayed, together with the length of any Basic program currently in the memory.

S This command executes a machine-code subroutine starting at the address given by O and then returns to the monitor.

Z Returns to Basic.

The program is used to load to monitor in reserved memory at the top of RAM. When run it will check for errors in the Data statements and inform you of any, in which case you should check through your listing against the one given. If there are no errors the monitor is installed and the loading program is Newed.

As previously mentioned, the program interrupts the key-scan routine to check if the arrow key has been pressed. Anybody interested in writing programs to use this — for example, a keyboard beep routine — will need to know the following.

Locations 363 and 364 contain the address to which the Dragon jumps when a key is pressed. To enable the interrupt, location 362 is Poked with 126, to disable the interrupt a value of 57 is Poked to location 362.

The second short program demonstrates how the Reset button can also be interrupted when pressed. The program asks for a message to be typed in and this message will then be printed before the OK prompt when ever the Reset key is pressed. This is achieved by changing locations 114 and 115 which point to the address to which the Dragon will jump when the Reset key is pressed.

It is important that the machine recovers correctly, so part of the Reset routine is copied from the ROM first of all in line 20, then your own machine-code program can follow this.

Finally, one very useful command that is missing from the Dragon's Basic is the Merge facility. However, this can be achieved as follows: type Cload "programone". When loaded type

? PEEK(25);PEEK(26);PEEK(27);PEEK(28)

Make a note of the four numbers displayed. Type

POKE 25, PEEK(27) : POKE 26, PEEK(28)-2

Now Cload "programtwo". Renumber it so that its first line number is higher than the last line number of the first program. Finally, Poke locations 25 and 26 with the original values. The programs should now have been merged. This works as locations 25 and 26 contain the Start address of the program and locations 27 and 28 contain the end address plus two of the program. This information can also be used to clear all of the graphics pages; usually you must have at least one page reserved. Type in

POKE 25,6 : NEW

and you will have just under 31K of free memory. Make sure that there is no program in the memory before you do this or it will create chaos.

Program 3 is a full 6809 disassembler program designed to run on the Dragon 32. Note that the program can be used with or without the printer, the only difference in output being that the hexadecimal code is also output to the printer whereas only the address and mnemonic is printed when disassembling to the screen.

All of the mnemonics are held in Data

statements at the end of the program in lines 890 onwards. Take care when entering these to insert the correct number of commas between each word as this is very important.

The symbol after each mnemonic signifies to which addressing mode, if any, the op-code refers; for example a "greater than" symbol means indexed addressing.

The main loop is from lines 140 to 350, this prints the correct mnemonic and transfers control to one of the subroutines to print any following data.

The use of Print with a channel number means that exactly the same program can be used for both the screen and printer. Line 90 sets PR to 0 for the screen, or -2 for the printer.

Line 30 sets up an 80-column printer, and although Dragon Data never mention this, this line should be included with any program that is going to use a printer.

Use Shift @ to halt the disassembly as the text scrolls up the screen at quite a pace. If you use the program to disassemble the Basic ROM it is quite easy to find some very useful subroutines that can be called from your own Basic or machine-code programs. For example, try entering the starting address as 48299 and you will get a disassembly of the ROM's print routine, which prints the character in register A.

```
31700      JSR < 37025 >BD90A1
31703      LDX < 136 )        9E88
31705      LDA  79            864F
31707      STA [X]            A784
31709      LEA X  1           3001
31711      LDA  125           867D
31713      STA [X]            A784
31715      LEA X  2           3002
31717      STX < 136 )        9F88
31719      LDB < 32765 )      F67FFD
31722      JSR < 32183 )      BD7DB7
31725      LDB < 32766 )      F67FFE
31728      JSR < 32183 )      BD7DB7
31731      JSR < 37025 )      BD90A1
31735      LDY < 32765 )      10BE7FFD
31739      STY < 32758 )      10BF7FF6
31742      LDX < 136 )        9E88
31744      LDA  124           867C
31746      STA [X]            A784
31748      LEA X  2           3002
31750      STX < 136 )        9F88
31752      JSR < 32121 )      BD7D79
31755      LDX < 32758 )      BE7FEE
31758      CMP A  42          812A
31760      BNE + 3            2603
31762      JMP < 32012 )      7E7D0C
31765      CMP X  0           8C0000
31768      BNE + 15           260F
31770      LDX < 136 )        9E88
31772      LDA  127           867F
31774      STA [X]            A784
31776      LEA X  1           3001
31778      STX < 136 )        9F88
31780      JSR < 37025 )      BD90A1
31783      BRA - 43           2005
31785      LDX  0             8E0000
31788      JSR < 32059 )      BD7D0B
31791      LDX < 32758 )      BE7FF6
31794      STB [X]            E784
31796      LEA X  1           3001
31798      STX < 32758 )      BF7FF6
31801      BRA - 61           20C3
31803      PULS 00110110 BIN  3536
31805      STX < 32758 )      BF7FEE
31809      STY < 32752 )      10BF7FF0
31813      STS < 32754 )      10BF7FF2
31816      STU < 32756 )      FF7FF4
31819      STA < 32758 )      B7FFF6
31822      STB < 32759 )      F7FFF7
31825      PSHS 00110110 BIN  3436
31827      JSR < 37025 )      BD90A1
31830      BRA + 22           2016
31832      PSHS 00000010 BIN  3402
31834      JSR < 37025 )      BD90A1
31837      PULS 00000010 BIN  3502
31839      LDX < 136 )        9E88
31841      STA [X]            A784
31843      LEA X  1           3001
31845      LDA  125           867D
31847      STA [X]            A784
31849      LEA X  2           3002
31851      STX < 136 )        9F88
31853      RTS                39
31854      LDA  65            8641
31856      BSR - 26           8DE6
```

(continued on next page)

```
250 IF X$="$" THEN 400
260 IF X$="&" THEN 430
270 IF X$=">" THEN 460
280 IF X$="<" THEN 680
290 IF X$="^" THEN 750
300 IF X$="/" THEN 820
310 IF PR=0 THEN 350
320 PRINT#PR,TAB(36);:FOR JJ=LI TO I:HE$=HEX$(PEEK(JJ)):IF LEN(HE$)<2 THEN HE$="
0"+HE$
330 PRINT#PR,HE$;
340 NEXT JJ
350 PRINT#PR,"":NEXTI:END
360 I=I+1:V=PEEK(I):PRINT#PR,V;
370 GOTO 310
380 I=I+1:V=PEEK(I)*256+PEEK(I+1):I=I+1:PRINT#PR,V;
390 GOTO 310
400 I=I+1:V=PEEK(I)
410 PRINT#PR,"(":V");
420 GOTO 310
430 I=I+1:V=PEEK(I)*256+PEEK(I+1):I=I+1
440 PRINT#PR,"(":V;")";
450 GOTO310
460 I=I+1
470 V=PEEK(I)
480 PRINT#PR,"E";
490 V=V AND 96
500 IF V=0 THEN P$="X"
510 IF V=32 THEN P$="Y"
520 IF V=64 THEN P$="U"
530 IF V=96 THEN P$="S"
540 PRINT#PR,P$;" ";
550 IF (PEEK(I)AND128)=0 THEN PRINT#PR,"+";(PEEK(I)AND31);"]";:GOTO670
560 V=PEEK(I)AND159
570 IF V=132 THEN PRINT#PR," ";:GOTO670
580 IF V=136 THEN PRINT#PR,"+";:GOTO360
590 IF V=137 THEN PRINT#PR,"+";:GOTO380
600 IF V=134 THEN PRINT#PR,"+A]";:GOTO670
610 IF V=133 THEN PRINT#PR,"+B]";:GOTO670
620 IF V=139 THEN PRINT#PR,"+D]";:GOTO670
630 IF V=128 THEN PRINT#PR," INC 1]";
640 IF V=129 THEN PRINT#PR," INC 2]";
650 IF V=130 THEN PRINT#PR," DEC 1]";
660 IF V=131 THEN PRINT#PR," DEC 2]";
670 GOTO310
680 I=I+1:V=PEEK(I)
690 P$=""
700 FOR J=7 TO 0 STEP-1
710 IF V<INT(2^J) THEN P$=P$+"0" ELSE V=V-INT(2^J):P$=P$+"1"
720 NEXTJ
730 PRINT#PR,P$" BIN";
740 GOTO310
750 I=I+1:V=PEEK(I)
760 IF V>127 THEN 790
770 PRINT#PR,"+";
780 GOTO810
790 V=256-V
800 PRINT#PR,"-";
810 GOTO 310
820 I=I+1:V=PEEK(I)*256+PEEK(I+1):I=I+1
830 IF V>32767 THEN 860
840 PRINT#PR,"+";
850 GOTO860
860 V=65536-V
870 PRINT#PR,"-";
880 GOTO310
890 DATA NEG $,,,ERR,,,ERR,,,COM $,,,LSR $,,,ERR,,,ROR $,,,ASR $,,,ASL $,,,ROL $
,,,DEC $,,,ERR,,,INC $,,,TST $,,,JMP $,,,CLR $,,,SFT,,,SFT2,,,NOP,,,SYNC,,,ERR,,
,ERR,,,ERR,,,LBRS %,,,
900 DATA ERR,,,DRA,,,OR CC #,,,ERR,,,AND CC #,,,SEX,,,EXG <,,,TFR <,,,BRA ^,LBRA
/,,BRN ^,LBRN /,,BHI ^,LBHI /,,BLS ^,LBLS /,,BHS ^,LBHS /,,BLO ^,LBLO /,,BHE ^,
LBHE /,,BEQ ^,LBEQ /,,BVC ^,LBVC /,,BVS ^,LBVS /,,BPL ^,LBPL /,,BMI ^,LBMI /,,BG
E ^,LBGE /,
910 DATA BLT ^,LBLT /,,BGT ^,LBGT /,,BLE ^,LBLE /,,LEA X >,,,LEA Y >,,,LEA S >,,
,LEA U >,,,PSHS <,,,PULS <,,,PSHU <,,,PULU <,,,ERR,,,RTS,,,ERR,,,RTI,,,CWAI #,,,
MUL,,,ERR,,,SWI 1,SWI 2,SWI 3,NEG A,,,ERR,,,ERR,,,COM A,,,
920 DATA LSR A,,,ERR,,,ROR A,,,ASR A,,,ASL A,,,ROL A,,,DEC A,,,ERR,,,INC A,,,TST
A,,,ERR,,,CLR A,,,NEG B,,,ERR,,,ERR,,,COM B,,,LSR B,,,ERR,,,ROR B,,,ASR B,,,ASL
B,,,ROL B,,,DEC B,,,ERR,,,INC B,,,TST B,,,ERR,,,CLR B,,,NEG >,,,ERR,,,ERR,,,COM
>,,,
930 DATA LSR >,,,ERR,,,ROR >,,,ASR >,,,ASL >,,,ROL >,,,DEC >,,,ERR,,,INC >,,,TST
>,,,JMP >,,,CLR >,,,NEG &,,,ERR,,,ERR,,,COM &,,,LSR &,,,ERR,,,ROR &,,,ASR &,,,A
SL &,,,ROL &,,,DEC &,,,ERR,,,INC &,,,TST &,,,JMP &,,,CLR &,,,SUB A #,,,CMP A #,,
,SBC A #,,
940 DATA SUB D %,CMP D %,CMP U %,AND A #,,,BIT A #,,,LDA #,,,ERR,,,EOR A #,,,ADC
A #,,,OR A #,,,ADD A #,,,CMP X %,CMP Y %,CMP S %,BSR ^,,,LDX %,LDY %,,,ERR,,,SUB
A $,,,CMP A $,,,SBC A $,,,SUB D $,CMP D $,CMP U $,AND A $,,,BIT A $,,,LDA $,,,S
TA $,,
950 DATA EOR A $,,,ADC A $,,,OR A $,,,ADD A $,,,CMP X $,CMP Y $,CMP S $,JSR $,,,
LDX $,LDY $,,,STX $,STY $,,,SUB A >,,,CMP A >,,,SBC A >,,,SUB D >,CMP D >,CMP U >,
AND A >,,,BIT A >,,,LDA >,,,STA >,,,EOR A >,,,ADC A >,,,OR A >,,,ADD A >,,,
960 DATA CMP X >,CMP Y >,CMP S >,JSR >,,,LDX >,LDY >,,,STX >,STY >,,,SUB A &,,,CMP
A &,,,SBC A &,,,SUB D &,CMP D &,CMP U &,AND A &,,,BIT A &,,,LDA &,,,STA &,,,EOR
A &,,,ADC A &,,,OR A &,,,ADD A &,,,CMP X &,CMP Y &,CMP S &,JSR &,,,LDX &,LDY &,
970 DATA STX &,STY &,,,SUB B #,,,CMP B #,,,SBC B #,,,ADD D %,,,AND B #,,,BIT B #,
,,LDB #,,,ERR,,,EOR B #,,,ADC B #,,,OR B #,,,ADD B #,,,LDD %,,,ERR,,,LDU %,LDS %
,,,ERR,,,SUB B $,,,CMP B $,,,SBC B $,,,ADD D $,,,AND B $,,,BIT B $,,,
980 DATA LDB $,,,STB $,,,EOR B $,,,ADC B $,,,OR B $,,,ADD B $,,,LDD $,,,STD $,,,
LDU $,LDS $,,STU $,STS $,,SUB B >,,,CMP B >,,,SBC B >,,,ADD D >,,,AND B >,,,BIT
B >,,,LDB >,,,STB >,,,EOR B >,,,ADC B >,,,OR B >,,,ADD >,,,LDD >,,,STD >,,,LDU >
,LDS >,,
990 DATA STU >,STS >,,SUB B &,,,CMP B &,,,SBC B &,,,ADD A &,,,AND B &,,,BIT B &,
,,LDB &,,,STB &,,,EOR B &,,,ADC B &,,,OR B &,,,ADD B &,,,LDD &,,,STD &,,,LDU &,L
DS &,,STU &,STS &,
```

(listing continued from previous page)

```
31850  LDB ( 32758 )  F67FF6
31861  JSR ( 32183 )  B07DB7
31864  LDA  66        8642
31866  BSR - 36       8DDC
31868  LDB ( 32759 )  F67FF7
31871  JSR ( 32183 )  B07DB7
31874  LDA  88        8658
31876  BSR - 46       8DD2
31878  LDB ( 32758 )  F67FEE
31881  JSR ( 32183 )  B07DB7
31884  LDB ( 32751 )  F67FEF
31887  JSR ( 32183 )  B07DB7
31890  LDA  89        8659
31892  BSR - 62       8DC2
31894  LDB ( 32752 )  F67FF0
31897  JSR ( 32183 )  B07DB7
31900  LDB ( 32753 )  F67FF1
31903  JSR ( 32183 )  B07DB7
31906  LDA  83        8653
31908  BSR - 78       8DB2
31910  LDB ( 32754 )  F67FF2
31913  JSR ( 32183 )  B07DB7
31916  LDB ( 32755 )  F67FF3
31919  JSR ( 32183 )  B07DB7
31922  LDA  85        8655
31924  BSR - 94       8DA2
31926  LDB ( 32756 )  F67FF4
31929  JSR ( 32183 )  B07DB7
31932  LDB ( 32757 )  F67FF5
31935  JSR ( 32183 )  B07DB7
31938  JSR ( 37025 )  BD90A1
31941  JSR ( 37025 )  BD90A1
31944  LDX ( 136 )    9E88
31946  LDA  80        8658
31948  STA [X]        A784
31950  LEA X  1       3001
31952  LDA  82        8652
31954  STA [X]        A784
31956  LEA X  1       3001
31958  LDA  79        8649
31960  STA [X]        A784
31962  LEA X  1       3001
31964  LDA  71        8647
31966  STA [X]        A784
31968  LEA X  2       3002
31970  STX ( 136 )    9F88
31972  LDD ( 27 )     DC1B
31974  SUB D  2       830002
31977  SUB D ( 25 )   9319
31979  STD ( 32758 )  FD7FEE
31982  LDB ( 32758 )  F67FEE
31985  JSR ( 32183 )  B07DB7
31988  LDB ( 32751 )  F67FEF
31991  JSR ( 32183 )  B07DB7
31994  JSR ( 37025 )  BD90A1
31997  JMP ( 32812 )  7E700C
32000  CMP A  9       8109
32002  BEQ + 1        2701
32004  RTS            39
32005  PSHS 00110110 BIN  3436
32007  LDA  57        8639
32009  STA ( 362 )    B7016A
32012  LDX ( 136 )    9E88
32014  LDA  95        865F
32016  STA [X + 0 ]   A7890000
32020  LEA X  1       3001
32022  STX ( 136 )    9F88
32024  JSR ( 41194 )  BDA8EA
32027  STA ( 32758 )  B7FFEE
32030  OR A  64       8A40
32032  LDX ( 136 )    9E88
32034  STA [X + 0 ]   A7890000
32038  LEA X  1       3001
32040  STX ( 136 )    9F88
32042  LDA ( 32758 )  B67FEE
32045  CMP A  90      815A
32047  BNE + 8        2608
32049  LDA  126       867E
32051  STA ( 362 )    B7016A
32054  PULS 00110110 BIN  3536
32056  RTS            39
32057  BRA + 59       2039
32059  LDA [X + 32758 ]  A6897FEE
32063  SUB A  57      8039
32065  BGT + 11        2E08
32067  LDA [X + 32758 ]  A6897FEE
32071  SUB A  48      8030
32073  LDB  16        C610
32075  MUL            3D
32076  BRA + 8        2008
32078  LDA [X + 32758 ]  A6897FEE
32082  SUB A  55      8037
32084  BRA - 13       20F3
32086  LDA [X + 32751 ]  A6897FEF
32090  SUB A  57      8039
32092  BGT + 15        2E0F
32094  LDA [X + 32751 ]  A6897FEF
32098  SUB A  48      8030
32100  NOP            12
32101  STA ( 32754 )  B77FF2
32104  ADD B ( 32754 )  FB7FF2
32107  BRA + 8        2008
32109  LDA [X + 32751 ]  A6897FEF
32113  SUB A  55      8037
32115  BRA - 17       20EF
32117  RTS            39
32118  JMP ( 32233 )  7E7DE9
32121  LDX  0         8E0000
32124  JSR ( 41194 )  BDA8EA
32127  CMP X  0       8C0000
32129  BNE + 17       2611
32131  CMP X  0       8C0000
32134  BEQ - 12       27F4
32137  LDY ( 136 )    109E88
32139  LEA Y  63      313F
32142  STY ( 136 )    109F88
32144  LEA X  31      301F
32146  BRA - 24       20E8
32148  CMP A  13      8100
32150  BNE + 4        2604
32152  JSR ( 37025 )  BD90A1
32155  RTS            39
32156  STA [X + 32758 ]  A7897FEE
32160  OR A  64       8A40
32162  CMP X  4       8C0004
32165  BHS + 14       240E
32167  LEA X  1       3001
32170  LDY ( 136 )    109E88
32172  STA [Y + 0 ]   A7890000
32176  LEA Y  33      3121
32179  STY ( 136 )    109F88
32181  BRA - 59       20C5
32183  STB ( 32767 )  F7FFFF
32186  LSR B  54      54
32187  LSR B  54      54
32188  LSR B  54      54
32189  AND B  15      C40F
32192  CMP B  9       C109
32194  BGT + 4        2E04
32196  ADD B  112     CB70
32198  BRA + 2        2002
32200  ADD B  55      CB37
32202  BSR + 18       8D12
32204  LDB ( 32767 )  F67FFF
32207  AND B  15      C40F
32209  CMP B  9       C109
32211  BGT + 4        2E04
32213  ADD B  112     CB70
32215  BRA + 2        2002
32217  ADD B  55      CB37
32219  BSR + 1        8D01
32221  RTS            39
32222  LDX ( 136 )    9E88
32224  STB [X + 0 ]   E7890000
32228  LEA X  1       3001
32230  STX ( 136 )    9F88
32232  RTS            39
32233  CMP A  79      814F
32235  BNE + 3        2603
32237  JMP ( 32307 )  7E7E33
32240  CMP A  74      8148
32242  BNE + 3        2603
32244  JMP ( 32343 )  7E7E57
32247  CMP A  83      8153
32249  BNE + 3        2603
32251  JMP ( 32394 )  7E7E8A
32254  CMP A  69      8145
32256  BNE + 3        2603
32258  JMP ( 32405 )  7E7E95
32261  CMP A  70      8146
32263  BNE + 3        2603
32265  JMP ( 32542 )  7E7F1E
32268  CMP A  77      814D
32270  BNE + 3        2603
32272  JMP ( 32614 )  7E7F66
32275  CMP A  82      8152
32277  BNE + 3        2603
32279  JMP ( 31003 )  7E7C3B
32282  CMP A  65      8141
32284  BNE + 3        2603
32286  JMP ( 31700 )  7E7BD4
32289  LDA  127       867F
32291  STA [X + 0 ]   A7890000
32295  LEA X  1       3001
32297  STX ( 136 )    9F88
32299  JSR ( 37025 )  BD90A1
32301  JMP ( 32812 )  7E700C
32304  LDX ( 136 )    9E88
32307  LDA  126       867E
32309  STA [X + 0 ]   A7890000
32311  LEA X  1       3001
32315  STX ( 136 ) —  9F88
-32317
32319  JSR ( 32121 )  BD7D79
32322  LDX  0         8E0000
32325  STB ( 32759 )  B7FFF0
32328  STB ( 32765 )  B7FFFD
32331  LDX  2         8E0002
32334  JSR ( 32859 )  BD7D3B
32337  STB ( 32766 )  B7FFFE
32340  JMP ( 32812 )  7E700C
32343  LDX ( 136 )    9E88
32345  LDA  126       867E
32347  STA [X + 0 ]   A7890000
32351  LEA X  1       3001
32353  STX ( 136 )    9F88
32355  JSR ( 32121 )  BD7D79
32358  CMP X  0       8C0000
32361  BGT + 3        2603
32363  JMP ( 32812 )  7E700C
32366  LDX  0         8E0000
32369  JSR ( 32859 )  BD7D3B
32372  STB ( 32392 )  F77E88
32375  LDX  2         8E0002
32378  JSR ( 32859 )  BD7D3B
32381  STB ( 32393 )  F77E89
32384  LDA  126       867E
32386  STA ( 362 )    B7016A
32389  PULS 00110110 BIN  3536
32391  JMP ( 33649 )  7E8371
32394  JSR ( 37025 )  BD90A1
32397  LDX ( 32765 )  BE7FFD
32400  JSR [X]        AD84
32402  JMP ( 32812 )  7E700C
32405  LDX  0         8E0000
32408  LDA  96        8660
32410  STA [X + 1024 ]  A7890400
32414  LEA X  1       3001
32416  CMP X  512     8C0200
32419  BNE - 11       26F5
32421  LDX  1024      8E0400
32424  STX ( 136 )    9F88
32427  LDY ( 32765 )  109EF7FD
32431  STY ( 32758 )  10BF7FF6
32434  LDA  14        860E
32436  STA ( 32757 )  B7FFF5
32439  LDB ( 32758 )  F67FF6
32442  JSR ( 32183 )  B07DB7
32445  LDB ( 32759 )  F67FF7
32448  JSR ( 32183 )  B07DB7
32451  LDA  9         8609
32453  LDX ( 136 )    9E88
32455  LEA X  1       3001
32457  STX ( 136 )    9F88
32460  LDY ( 32758 )  109EF7FE
32463  LDB [Y]        E6A4
32465  LEA Y  33      3121
32468  STY ( 32758 )  10BF7FF6
32471  JSR ( 32183 )  B07DB7
32474  DEC A          4A
32475  BNE + 24       26E8
32477  JSR ( 37025 )  BD90A1
32480  LDA ( 32757 )  B67FF5
32483  DEC A          4A
32484  BEQ + 9        2709
32486  STA ( 32757 )  B7FFF5
32489  BRA - 52       20CC
32491  LDX ( 136 )    9E88
32493  LDA  126       866A
32495  STA [X]        A784
32497  LEA X  1       3001
32499  STX ( 136 )    9F88
32501  JSR ( 41194 )  BDA8EA
32504  CMP A  13      810D
32506  BNE + 10       260A
32508  LDX ( 32765 )  BE7FFD
32511  LEA X  1       3001
32513  STX ( 32765 )  BF7FFD
32516  BRA - 97       209F
32518  CMP A  12      810C
32520  BNE + 18       2612
32522  LDX ( 32765 )  BE7FFD
32525  LEA X  31      301F
32527  STX ( 32765 )  BF7FFD
32530  BRA - 16       20F0
32532  CMP A  32      8120
32534  BNE - 35       26DD
32536  JSR ( 37025 )  BD90A1
32539  JMP ( 32812 )  7E700C
32542  LDA  126       867E
32544  LDX ( 136 )    9E88
32546  STA [X]        A784
32548  LEA X  1       3001
32550  STX ( 136 )    9F88
32552  JSR ( 32121 )  BD7D79
32555  LDX  0         8E0000
32558  JSR ( 32859 )  BD7D3B
32561  STB ( 32757 )  B7FFF5
32564  LDX  2         8E0002
32567  JSR ( 32859 )  BD7D3B
32570  STB ( 32758 )  B7FFF6
32573  LDX ( 136 )    9E88
32575  LDA  124       867C
32577  STA [X]        A784
32579  LEA X  1       3001
32581  STX ( 136 )    9F88
32583  JSR ( 32121 )  BD7D79
32586  LDX  0         8E0000
32589  JSR ( 32859 )  BD7D3B
32592  LDX ( 32765 )  BE7FFD
32596  LDY ( 32757 )  109E7FF5
32599  STB [X]        E784
32601  LEA X  1       3001
32603  LEA Y  63      313F
32606  CMP Y  0       108C0000
32609  BNE + 12       26F4
32611  JMP ( 32812 )  7E700C
32614  LDA  126       867E
32616  LDX ( 136 )    9E88
32618  STA [X]        A784
32620  LEA X  1       3001
32622  STX ( 136 )    9F88
32624  JSR ( 32121 )  BD7D79
32627  LDX  0         8E0000
32630  JSR ( 32859 )  BD7D3B
32633  STB ( 32757 )  B7FFF5
32636  LDX  2         8E0002
32639  JSR ( 32859 )  BD7D3B
32642  STB ( 32758 )  B7FFF6
32645  LDA  126       867E
32647  LDX ( 136 )    9E88
32649  STA [X]        A784
32651  LEA X  1       3001
32653  STX ( 136 )    9F88
32655  JSR ( 32121 )  BD7D79
32658  LDX  0         8E0000
32661  JSR ( 32859 )  BD7D3B
32664  STB ( 32759 )  B7FFF7
32667  LDX  2         8E0002
32670  JSR ( 32859 )  BD7D3B
32673  STB ( 32760 )  B7FFF8
32676  LDX ( 32765 )  BE7FFD
32680  LDY ( 32759 )  108E7FF7
32683  LDA [X]        A684
32685  STA [Y]        A7A4
32687  LEA X  1       3001
32689  LEA Y  33      3121
32692  STY ( 32759 )  10BF7FF7
32695  LDY ( 32757 )  109E7FF5
32699  LEA Y  63      313F
32702  STY ( 32757 )  10BF7FF5
32705  CMP Y  0       108C0000
32709  BNE - 32       2660
32711  JMP ( 32812 )  7E700C
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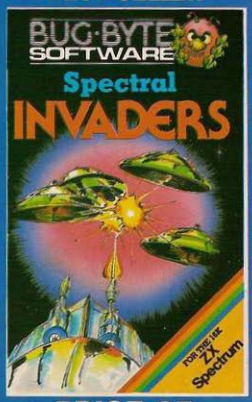

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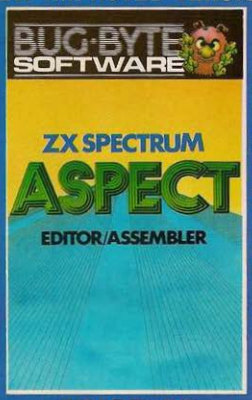

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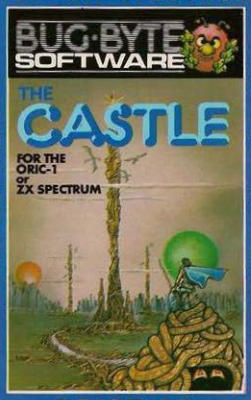

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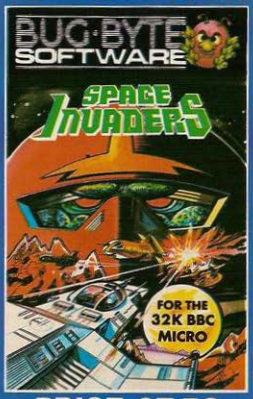

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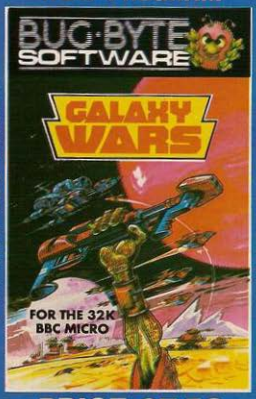

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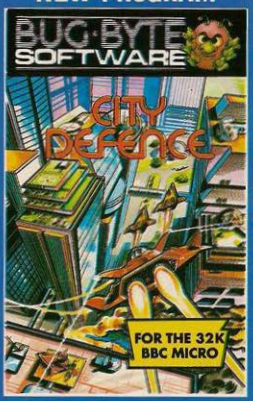

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- 24K bytes of ROM;
- 32 bytes of RAM, at least 28K of which is available to the user.

THE SCREEN DISPLAY

- 40 or 80 characters to the line – without affecting the 28K bytes of RAM at your disposal;
- 24 or 30 lines to the screen;
- well-formed characters, with true descenders;
- a full European character set;
- normal or reverse video, high resolution graphics on screen of controllable size, 256, 320, 512 or 640 horizontal resolution by 250 vertical lines;
- a facility to set up a "page" of up to 255 lines, with the screen acting as a "window" to display it;
- ability to maintain several such pages simultaneously, and to switch rapidly between them;
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CHARACTER SET

- 512 characters, including the full ASCII set, all European accented characters, Greek and graphics symbols.

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- an expansion interface for NewBrain system expansion modules.

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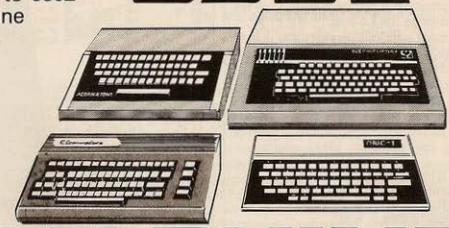
6502 MACHINE CODE MADE EASY

Darryl Mattocks continues his guide to 6502 machine code.



IF YOU ENTERED the programs last month, then you may have been perturbed by the speed of them: how can we slow them down?

The most common method is using a delay subroutine like the one in figure 1.

This is a delay loop. It works by introducing a delay of around 0.5 seconds each time it is called. Unfortunately, it resets the X and Y registers to 0, which in a program where X and Y are used extensively is not a good idea. To get around this we grab two free memory bytes and use them as variables. This makes the program a bit harder to understand, but now X and Y are not changed within the subroutine.

Any two free memory bytes will do. I used $FE and $FF — 254 and 255 — in the example in figure 2 as they are not used on the Vic-20, but any two will do.

We still have the same overall effect, but X and Y remain unchanged. Unfortunately we had to use the accumulator, but this is excusable as 90 percent of all machine-code subroutines use it and so it is unwise to store anything of importance in there for too long a time. So we have a delay loop. Let us add it to our sound program of last month. See figure 3.

Line 100 in last month's loader would now read:

```
100 DATA A9,00,8D,0E,90, A2,FF,A0,00,CA,
    8E,0A,90,8C,0B,90,20,42,1A
102 DATA C8,D0,F3,60,A9,00,85,FE,85,FF,E6,
    FF,D0,FC,E6,FE,D0,F6,60
```

An important point to note is that the branch instruction in the sound section has changed from last month so as to obtain a better effect. As we have added a JSR instruction into our loop, we have added three extra bytes of code, so the branch has altered correspondingly. To run it, type in SYS 6700 and you will experience some weird effects.

This is what we call reading the memory and not remembering the post-code. So far three types of command have been used: first, commands which do not have an operand, for example INY and DEX. Second, branch instructions which precede a displacement rather than an actual memory address. Third, Jump commands — JSR — which precede a memory location. Fourth, commands which access the contents of a specified address.

This is just the tip of the iceberg; there are seven different ways of addressing memory: immediate, absolute, zero page, relative, indirect, indirect pre-indexed with X, and implied-implied addressing.

In immediate addressing the actual value of the operand is manipulated. The immediate addressing is expressed by putting a hash sign in front of the operand. Thus,

```
LDA # 5
```

means load the accumulator with 5, or in Basic A=5. With absolute addressing we Load from, Add to or Store into an address which is stored in two bytes immediately after the op-code. So

```
LDA 2048
```

means load the accumulator with the value stored in byte 2048, or, in Basic, A=Peek (2048).

Zero-page is absolute addressing except that all the locations are in zero-page — bytes 0 to 255 — inclusive. As one byte can hold values of 0 to 255, the zero-page addressing requires two bytes, op-code and address. In this case,

```
LDA 38
```

means load the accumulator with the value stored in byte 0038. The Basic equivalent is simply

```
A=PEEK(3*16+8)
```

Relative addressing is the type of addressing used in branch statements, that is, a displacement which is added to or subtracted from the program counter.

```
BEQ 3A
```

means if the zero flag is set — Z=1 — in the status register then skip 3A bytes of memory. There is no direct equivalent to this in Basic, but if we imagined that * symbolished the current line of code being executed, then

```
10 REM
20 X=X-1
30 IF X=0 THEN *=*-10:REM GOTO 20
```

With the indirect post-indexed with Y addressing technique, the contents of the byte specified in the operand and the following byte are converted into an address. The contents of Y are then added to this address and it is then this address that is manipulated. The indirect with Y is symbolised by brackets around the Operand and then a"Y" outside the bracket to indicate that it is post- and not pre-indexed; for example:

```
LDA (32),Y
```

If Y is equal to 12 decimal, byte 32 is equal to 41 decimal and byte 33 is equal to 22 decimal.

Then the accumulator would be loaded with the contents of byte 5685 — where

5685 = 12 + 41 + 22*256

In Basic this would appear as

```
A=PEEK (PEEK(32)+256*PEEK(33)+Y)
```

Indirect — pre-indexed with X addressing is similar to the previous case except now we add the contents of the X register to the operand and then take this new operand as the address of the first byte of the final address acquired. The symbolism for this type of addressing is again the brackets around the Operand but now we put a X inside the brackets:

```
LDA (32,X)
```

If X=4, byte 36=201 and byte 37=21 then the accumulator would be loaded with the contents of byte 5577, where

5577 = 201 + 21*256

In Basic this would look something like

```
A=PEEK(PEEK(32+x)+256*PEEK(32+x))
```

Implied-implied addressing requires no operand and often has very little to do with the memory at all. The op-codes in this category are mainly for changing the data in the registers. Thus INY means increment the Y register:

Y = Y + 1

If one byte can contain 256 different values, then how can a computer access a memory of 65,536 — 64K — bytes? The answer is to use two bytes to represent each address.

So using two bytes for every address, we can have a total of 256 multiplied by 256 — 64K — different addresses. It is no coincidence, then, that if you add up the total amount of RAM memory and ROM memory you get 64K. Some computers such as the CBM-64 use what is known as a virtual memory system whereby the computer splits the memory up into lots of 16K blocks and then pretends to only have 16K at a time.

(continued on next page)

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An address is made up of two bytes: Hi-byte — or page number, where one page is 256 bytes and 256 pages is 64K — and another byte to represent one particular byte out of the 256 in one page, the Lo-byte.

Life is made simpler if hexadecimal is used throughout, as by definition in a hex number such as 1234. The page number is 12 leaving the 34 as the Lo-byte or byte number. The best way to convert a decimal number into a machine-code address — if the computer is at hand — is to go through the following sequence. For example, 10845 decimal is equal to.

```
PRINT INT(10845/4096) = 2     = 2
PRINT (10845-2*4096)  = 2653
PRINT INT(2653/256)   = 10    = A
PRINT (2653-10*256)   = 93
PRINT INT(93/16)      = 5     = 5
PRINT (93-5*16)       = 13    = D = 2A5D hex
```

The convention for storing addresses in machine code is that they should always be in a Lo-byte, Hi-byte order. So 10845 would be stored as 5D,2A and not as 2A,5D.

A program with all two-byte addresses will be slower to run than one containing only one-byte addresses, but having only one byte to represent an address means a maximum 255 — one page — of memory. To speed things up, we take the first 256 bytes of memory — 0000 00FF — and call them the zero-page — due to the page number being equal to zero.

A lot of both business and games programs use machine code to move through memory one byte at a time. Word processors have a cursor rushing through sheets of text and Space Invader games have a running total of the number of bullets on the screen at a time. To do this in Basic, we would have something to the tune of

```
FORA=0TON : POKEA,X : NEXT
```

Notice the use of A as an address which varies. This is an indirect Poke; load X into the byte whose address is stored in the variable A; to convert this into machine code it would be best then to use an indirect command pre- or post-indexed with either X or Y respectively.

Try moving a character across and down the screen on a Vic. The screen is larger than 256 bytes so we are going to have to use a Lo-byte Hi-byte system and increment it as we move our * across. But first, advanced adding up should be considered.

When adding up in two bytes we can still use the ADC — Add with carry — command which can be thought of as

ADC : A = A + (data) + (carry)

Add the data represented in the ADC command to the contents of the accumulator and then add the contents of the carry flag — either 0 or 1.

To add in two bytes we add the Lo-bytes, store them and then add the Hi-bytes. Simple? Not quite. We need some way of telling whether the total of the two Lo-bytes came to more than 255 so that we can either add an extra 255 in the form of incrementing the Hi-byte total or not as the case may be. Enter the carry flag. The adding of the carry flag, which at first seemed to be a nuisance now makes sense in that in a two-byte addition, if the sum of Lo-bytes is greater than 255 this is automatically taken care of in the Hi-byte stage thanks to the ADC command adding the carry flag for us. A flowchart can now be translated into machine code.

Figure 1.

```
OPCODE   MNEMONIC   BASIC EQUIVALENT
A2 00    LDX #0     10 X=0
A0 00    LDY #0     20 Y=0
C8       INY        30 Y=Y+1
D0 FD    BNE FD     40 IF Y<> 256 THEN 30
E8       INX        50 X=X+1
D0 F8    BNE F8     60 IF X<> 256 THEN 20
60       RTS        70 RETURN
```

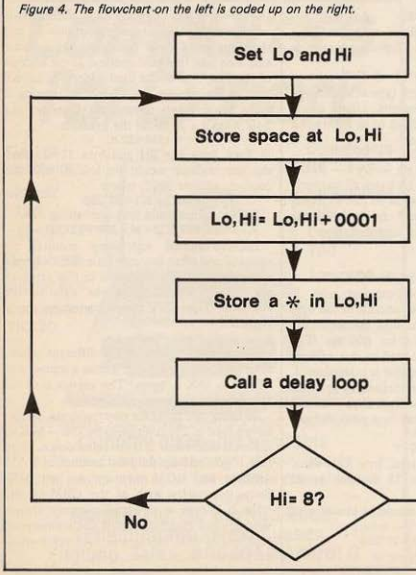
Figure 2.

```
OPERAND  MNEMONIC   BASIC EQUIVALENT
A9 00    LDA #0     10 A=0
85 FE    STA FE     20 POKE254,A
85 FF    STA FF     30 POKE255,A
E6 FF    INC FF     40 POKE255,PEEK(255+1)
D0 FC    BNE FC     50 IFPEEK(255)<>0THEN40
E6 FE    INC FE     60 POKE254,(PEEK(254)+1)
D0 F6    BNE F6     70 PEEK(254)<>0THEN30
60       RTS        80 RETURN
```

Figure 3.

```
MEMORY   OPCODE   MNEMONIC   BASIC
LOCATION  ≡        ≡         ≡
1A2C     A9 00    LDA #0F    10 A=15
1A2E     8D 0E 90 STA 900E   20 POKE 36878,A
1A31     A2 FF    LDX #FF    30 X=255
1A33     A0 00    LDY #0     40 Y=0
1A35     CA       DEX        50 X=X-1
1A36     8E 0A 90 STX 900A   60 POKE 36874,X
1A39     8C 03 90 STY 9003   70 POKE 36875,X
1A3C     20 42 1A JSR 1A42   80 GOSUB 120
1A3F     C8       INY        90 Y=Y+1
1A40     D0 F3    BNE 1A34   100 IF Y<>256THEN 50
1A42     60       RTS        110 END
1A43     A9 00    LDA #0     120 REM
1A45     85 FE    STA FE     130 REM
1A47     85 FF    STA FF     140 REM
1A49     E6 FF    INC FF     150 REM
1A4B     D0 FC    BNE 1A4B   160 REM
1A4D     E6 FE    INC FE     170 REM
1A4F     D0 F6    BNE 1A47   180 REM
1A51     60       RTS        190 REM
```

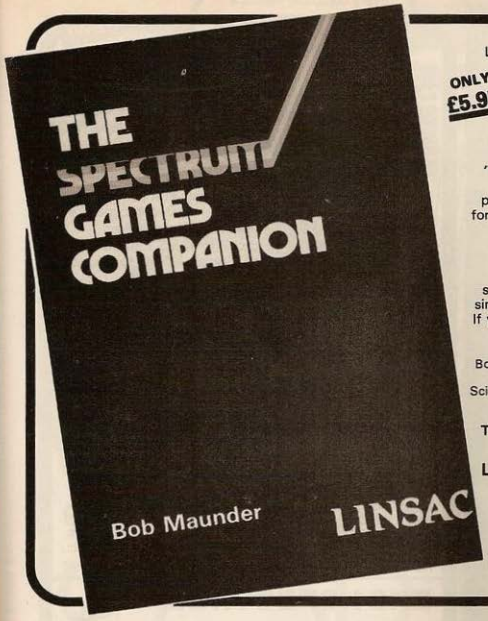
Figure 4. The flowchart on the left is coded up on the right.




```
MEMORY   OPCODE   MNEMONIC   BASIC EQUIVALENT
LOCATION
1a2c     a8 00    ldy #$00   10 Y=0:REM$$$  set lo and hi
1a2e     a9 1e    lda #$1e   20 A=30
1a30     85 fd    sta $fd    30 POKE253,A
1a32     a9 00    lda #$00   40 A=0
1a34     85 fc    sta $fc    50 POKE252,A
1a36     a9 20    lda #$20   60 A=32:REM$$$ store space at lo,hi
1a38     91 fc    sta ($fc),y 70 POKE(PEEK(252)+256*PEEK(253)+Y),a
1a3a     18       clc        80 CR=0:REM LO HI = LO HI + 0001
1a3b     a5 fc    lda $fc    90 A=PEEK(252)
1a3d     69 01    adc #$01   100 A=A+1+CR:IFA>255THENA=A-256:CR=1
1a3f     85 fc    sta $fc    110 POKE252,A
1a41     a5 fd    lda $fd    120 A=PEEK(253)
1a43     69 00    adc #$00   130 A=A+0+CR:IFA>255THENA=A-256:CR=1
1a45     85 fd    sta $fd    140 POKE253,A
1a47     a9 2a    lda #$2a   150 A=42
1a49     91 fc    sta ($fc),y 160 POKE(PEEK(252)+256*PEEK(253)+Y),a
1a4b     20 55 1a jsr $1a55  170 GOSUB230:REM$$$ call delay loop
1a4e     a5 fd    lda $fd    180 A=PEEK(253):REM HI = 8 ?
1a50     c9 08    cmp #$08   190 Z=0:IFA=8THENZ=1
1a52     d0 e2    bne $1a36  200 IFZ<>1THEN60
1a54     60       rts        210 END
1a55     a9 00    lda #$00   220 A=0:REM$$$ delay loop
1a57     85 fe    sta $fe    230 POKE254,A
1a59     85 ff    sta $ff    240 POKE255,A
1a5b     e6 ff    inc $ff    250 POKE255,PEEK(255)+1
1a5d     d0 fc    bne $1a5b  260 IFPEEK(255)<>256THEN250
1a5f     e6 fe    inc $fe    270 POKE254,PEEK(254)+1
1a61     d0 f6    bne $1a59  280 IFPEEK(254)<>256THEN240
1a63     60       rts        290 RETURN
```

Line 100 in the loader program for this would be

```
100 DATA A0,00,A9,1E,85,FD,A9,00,85,FC,A9,20,91,FC,18,A5,FC,69,01,85
102 DATA FC,A5,FD,69,00,85,FD,A9,2A,91,FC,20,55,1A,A5,FD,C9,08,D0,E2
104 DATA 60,A9,00,85,FE,85,FF,E6,FF,D0,FC,E6,FE,D0,F6,60
```



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Bob Maunder is co-author of 'The ZX80 Companion' and author of 'The ZX81 Companion'. He is a Senior Lecturer in Computer Science at Teesside Polytechnic, holds an MSc degree in Computer Science, and is a Member of the British Computer Society.

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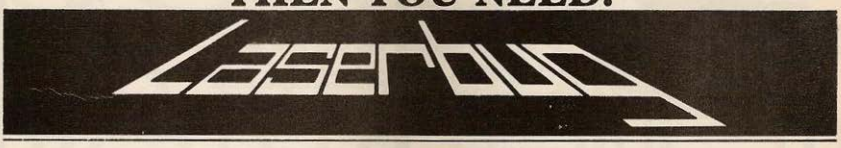

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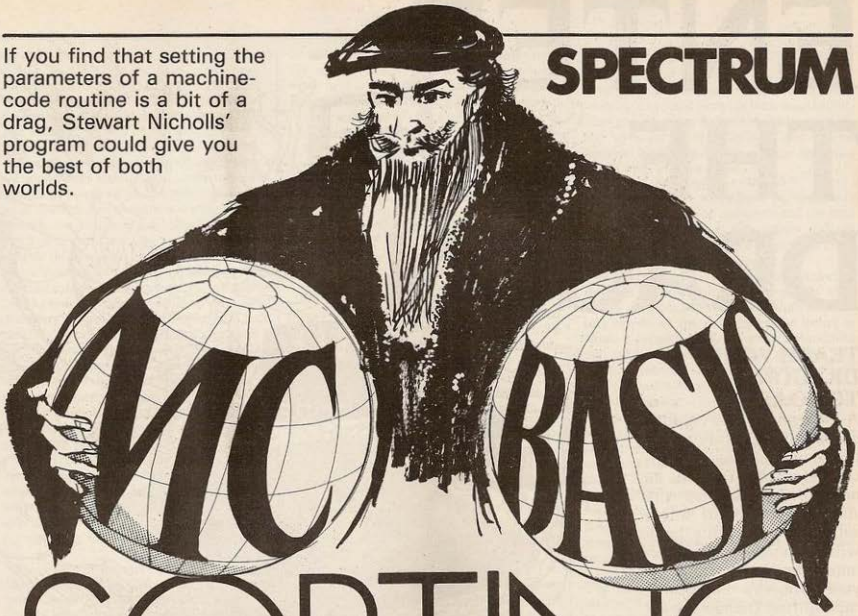

SORTING VARIABLES

DO YOU GET tired of having to set parameters of a machine-code routine by Poking numerous addresses with the necessary values? If you do, the following machine-code routine is the answer: it makes Poking completely unnecessary.

The problem is avoided by setting up the values using Basic variables and then searching the variables area to find their value and storing them in the spare bytes of the printer buffer.

To demonstrate the technique, I have attached the search program to a routine which prints a message anywhere on the screen using characters of any height or width, in any ink colour.

The x and y variables are used for the start of the message; since these are the co-ordinates of the top-left corner of the first character of the message the usual Spectrum plot positions apply. That is, 0,0 is the bottom left-hand corner of the screen. For the height of the characters, h is used. Normal height is 1, 22 will be full screen. Width of characters is w. Normal width is 1, 32 is full screen for one character.

The string containing the message to be printed will be a$. The only limitations on the message are that it can only contain characters from code 32 — space — to code 127 — copyright — and that the number of characters multiplied by width of character should not exceed 32 with the Plot position at the left-hand edge of screen. If this is exceeded the program will not crash but the message will wrap round the screen overprinting as it goes.

The program is fully mug-trapped and any wrong parameter of x and y will be corrected before plotting the string. The machine code to find the variables x, y, h, w and a$ is shown in listing 1.

If you read through Chapter 24 of the Sinclair Manual you will see that there are six types of variable, namely: a number whose name is one letter — type (i); a number whose name is two or more letters — type (ii); an array of numbers — type (iii); For-Next loop control — type (iv); string variable — type (v); an array of characters — type (vi).

Each of these variables is uniquely identified by its first byte.

Variable type i = 96d + (letter code - 96d)
Variable type ii = 160d + (first letter code - 96d)

(continued on page 137)

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(continued from page 135)

Variable type iii = 128d + (letter code - 96d)
Variable type iv = 224d + (letter code - 96d)
Variable type v = 64d + (letter code - 96d)
Variable type vi = 192d + (letter code - 96d)

The variables we will be searching for will be types (i) and (v).

If we take, for example, the variable x which has a character code of 120, then using the formula (i) given, its unique first byte is 120. So in order to find variable x we must search through the variables for this unique code, which will then point to the start of the x variable information. This is not just a simple case of running through the variables one byte at a time using a CPIR instruction, as this may find the code 120 held in a string or an array of characters. So we must find the start of each variable, check if it is the one we want, and if not, then jump to the start of the next variable. This means that we must identify the type of variable found before we know how far to jump to the next one. This is not as difficult a task as it might first appear because of the way in which the Spectrum stores the variable parameters.

With three of the variables, namely array of numbers, array of characters and strings, the length of the variable is held in the two bytes following the unique code byte. What is more helpful, bit 5 of the unique code is zero and the remaining three variables have bit 5 set at one

The length of the three remaining variables can be calculated by this method:

Type (i) length = 6 bytes including unique code.
Type (ii) length = number of letters of variable + 5 bytes
Type (iv) length = 19 bytes including unique code.

We now have the information to enable us to jump over each type of variable, and the checks must be made in the following order: first, check if code is 120; if yes then return from routine; check bit 5 and if zero jump by

value in next two bytes + 1 : GOTO 1

Check bit 6 and if zero check following bytes for

BIT 7 = 1

that is the last character of the variable, then jump six bytes and Goto 1. Check bit 7 and if zero then jump 6 bytes and Goto 1. Now it must be a For/Next loop so jump 19 bytes and Goto 1.

The mnemonics of the machine-code program to do this are shown in the Find subroutine. This uses address 23728 to hold the unique code of the variable for which we are searching. The HL register holds the address being checked, and the accumulator is loaded with the unique code from address 23728.

The subroutine only takes 46 bytes to check, Jump and locate the start address of any variable.

Now that we have found the start address of our variable x we must find its value. You will see that the value for whole numbers is held in the third and fourth bytes following the unique code. In our case we are only interested in numbers from 0 to 255 for x. So we can ignore the high byte and store the low byte, that is the third byte. This applies to all our variables x, y, h and w.

With this in mind a subroutine, Setup, can be assembled to move along three bytes from the address held in HL and then store the value held in this address in the printer buffer area of memory. So we now have the means of finding and storing values of x, y, h and w in addresses 23296/7/8 and 9.

We can now move to the slightly more complicated string parameters. In our case we need to find a$, unique code 65. The same Find routine can be used to find the start of the variable. Once found we then move to the next two bytes to find the LEN of the string as follows:

```
INC HL
LD E,(HL)
INC HL
LD D,(HL)
```

This will put the length of the string into the DE register, and, as we can safely limit the length of the string to 255 characters we only need to store the number in low byte:

```
LD (23300),DE
```

The number in address 23301 will be overwritten with the first character in the string:

```
PUSH DE      Get number of characters into
             BC
POP  BC
INC  HL      Set Hl at start of characters
LD   DE,23301
LDIR         Transfer information
```

The above will transfer the string characters from the variables to the printer buffer starting at address 23301.

With this routine we now have x, y, h, w, length of string, and characters in string stored consecutively in the printer buffer, and can go straight into the routine to plot the string based on these parameters.

The plot routine finds the start of the eight bytes for each character in the character set and, for each byte, a Rotate Left instruction is carried out either plotting or unplotting depending whether Carry is set or not. Again use is made of the two unused bytes in the Systems Variables 23728/9 to hold and update the x,y plot positions for each character.

If the y plot position goes below zero, then it is reset to 175 to give a wrap around effect and likewise if the x position goes above 255 it is reset to zero. So now we have a machine-code program that can be called from Basic with no Pokes in sight — for example:

```
10 LET x = 0 : LET y = 100 : LET h = 8 :
   LET w = 4 : LET a$ = "Finished" : INK 6 :
   RANDOMISE USR 32393
```

This saves 13 Pokes including LEN a$. Listing 1 shows the Basic program to set up the machine code above RAMtop. On a 16K Spectrum this is immediately before the user-defined graphics and occupies 255 bytes. Once the machine-code is entered the Basic can be Newed and the code saved in the usual way.

There are a couple of points to watch with this program. First, ensure that all the variables are defined before a call is made to the routine as failure to find a variable will crash the program. Second, Do not use x, y, h, or w as a control variable for a For-Next loop because the Spectrum will then delete the simple variable and use the For-Next loop to hold further values of x, y, h and w. This can be demonstrated by the simple Basic program:

```
10 FOR a = 1 TO 10
20 PRINT a ;
30 NEXT a
40 LET a = 3
50 NEXT a
```

This program will produce a continuous loop resetting a to 3 and jumping back into the For-Next loop showing that the variable — a — in line 40 is part of the For-Next loop control variable. If this was not the case the Spectrum would give an error report:

1 NEXT without FOR, 50:1

You can have a small Basic subroutine to work out the width of characters and the start plot position to give information printed centrally on any line; such a program is given in listing 2 with sample printout.

We can now also tackle a machine-code program to print out all the variables used after a program has been Run. Note that this may not be all the variables in the listing as when a program is Run certain subroutines may not have been called and so variables held in those routines will not have been placed into the variables area.

This program — listing 3 — could be of use in debugging Basic programs. Listing 3 is in the form of a machine-code dump which should be held in Data statements as listing 1, and Poked into a memory position of your choice. There are no Jump or Call commands to within the program. I find it handy to have two versions of the program one stored above RAMtop and another in a line 1 Rem statement containing 311 zeros and called using

RANDOMISE USR 23760

The machine-code is then held in the Basic area of RAM and can be Merged with any program — as long as the program does not have a line 1, which will be overwritten. One point to note when Saving the Basic Rem statement on tape is to use Clear to erase all variables used in the machine-code loader, otherwise these will be saved and Merged along with the Rem statement. This is good practice on any program which does not require the variables to be saved.

Listing 4 is a demonstration program setting up variables, and shows a screen copy of the machine-code output which lists these variables under their variable types. Notice how the Spectrum converts all variables to lower case and also that variables a, h, l, o, w, x and z have been listed under the For-Next loop only and not under number.

Listing 5 shows the machine-code mnemonics for assembly into a Rem statement, for anyone who wishes to check through the program to see how it works. The first section from address 5CD0 to 5CE5 sets up the Border, Paper and Ink colours; from 5CE6 to 5D46 prints the heading. The remainder of the program checks the variables one by one finding the type of variable, locating the next Print position in that variables column, updating the Print position and printing the variable.

The section from 5D94 to 5DBE is interesting in that it checks for a column reaching the bottom of the screen and if it does then waits for a key press before scrolling 21 lines, leaving the heading on the screen and printing the next variable in position. A return to Basic is only made when all the variables have been listed.

(continued on page 140)

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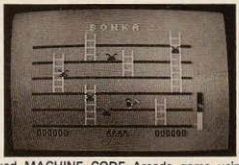

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(continued from page 137)

Start address for 16K machine code 32235.
ORG 32335
Subroutine to find variables.

```
[illegible]  LD    HL,(23627)
START  LD    A,(23728)
       CP    (HL)
       RET   Z
       BIT   6,(HL)
       JR    NZ,NEXT
       INC   HL
       LD    E,(HL)
       INC   HL
       LD    D,(HL)
       ADD   HL,DE
       INC   HL
       JR    START
NEXT   BIT   6,(HL)
       JR    NZ,NEXT1
LOOP5  INC   HL
       LD    A,(HL)
       BIT   7,A
       JR    Z,LOOP5
LOOP6  LD    DE,6
       ADD   HL,DE
       JR    START
NEXT1  BIT   7,(HL)
       JR    Z,LOOP6
       LD    DE,19
       ADD   HL,DE
       JR    START
```

Subroutine to set parameters of variable to be found.

```
[illegible]  LD    (23728),A
       CALL  [illegible]
       INC   HL
       INC   HL
       INC   HL
       LD    A,(HL)
       LD    (BC),A
       RET
```

Start of machine-code routine.

```
[illegible]  LD    BC,23296
       LD    A,120
       CALL  [illegible]
       INC   BC
       LD    A,121
       CALL  [illegible]
       INC   BC
       LD    A,104
       CALL  [illegible]
       INC   BC
       LD    A,119
       CALL  [illegible]
       LD    A,65
       LD    (23728),A
       CALL  [illegible]
       INC   HL
       LD    E,(HL)
       INC   HL
       LD    D,(HL)
       LD    (23300),DE
       PUSH  DE
       POP   BC
       INC   HL
       LD    DE,23301
       LDIR
```

Routine to plot the string.

```
       LD    HL,(23296)
       XOR   A
       LD    B,H
       SBC   176
       JR    C,YES
       LD    H,A
       LD    (23296),HL
YES    LD    (23728),HL
       LD    HL,23301
RUN1   PUSH  HL
       LD    A,(HL)
       LD    H,0
       LD    L,A
       ADD   HL,HL
       ADD   HL,HL
       ADD   HL,HL
       LD    DE,15360
       ADD   HL,DE
       LD    B,8
LOOP4  PUSH  BC
       LD    BC,(23297)
LOOP3  LD    A,(HL)
       PUSH  HL
       PUSH  BC
       LD    B,8
LOOP2  PUSH  BC
       RLA
       PUSH  AF
       JP    C,PLOT
       LD    HL,(23299)
       LD    A,(23728)
       ADD   L
       LD    (23728),A
       JP    END
PLOT   LD    BC,(23298)
LOOP1  PUSH  BC
       LD    BC,(23728)
       PUSH  BC
       CALL  22E5H
       POP   BC
       INC   C
       LD    (23728),BC
       POP   BC
       DJNZ  LOOP1
END    POP   AF
       POP   BC
       DJNZ  LOOP2
       LD    A,(23296)
       LD    HL,23728
       LD    (HL),A
       INC   HL
       XOR   A
       LD    A,(HL)
       SBC   176
       JR    C,OK
       LD    (HL),A
       JR    CONT
OK     LD    A,(HL)
       CP    0
       JR    NZ,OK1
       LD    (HL),176
OK1    DEC   (HL)
CONT   POP   BC
       POP   HL
       DJNZ  LOOP3
       INC   HL
       POP   BC
       DJNZ  LOOP4
       LD    A,(23299)
       ADD   A
       ADD   A
       ADD   A
       LD    L,A
       LD    A,(23728)
       ADD   L
       LD    (23296),A
       LD    (23728),A
       LD    A,(23297)
       LD    (23729),A
       POP   HL
       INC   HL
       LD    A,(23300)
       DEC   A
       RET   Z
       LD    (23300),A
       JP    RUN1
       END
```

Listing 1.

```
  1 REM x=x axis
  2 REM y=y axis
  3 REM h=height
  4 REM w=width
  5 REM a$=message
 10 CLEAR 32334
 20 LET start=32335
 30 FOR a=start TO 32599
 40 READ code
 50 POKE a,code
 60 NEXT a
 70 DATA 42,75,92,58,176,92,190
,200,203,110,32,8,35,94,35,86,25
,35,24,239,203,116,32,12
 80 DATA 35,126,203,127,40,250,
17,6,0,25,24,223,203,126,40,246,
17,19,0,25,24,213,50,176
 90 DATA 92,205,79,126,35,35,35
,126,2,201,1,0,91,62,120,205,125
,126,3,62,121,205,125,126
 100 DATA 3,62,104,205,125,126,3
,62,119,205,125,126,62,65,50,176
,92,205,79,126,35,94,35,86
 110 DATA 237,83,4,91,213,193,35
,17,5,91,237,176,42,0,91,175,124
,222,176,56,4,103,34,0
 120 DATA 91,34,175,92,33,5,91,2
29,126,38,0,111,41,41,41,17,0,60
,25,6,8,197,237,75
 130 DATA 1,91,126,229,197,6,8,1
97,23,245,218,249,126,42,3,91
 140 DATA 58,176,92,133,50,176,9
2,195,15,127,237,75,2,91,197,237
,75,176,92,197,205,229,34,193
 150 DATA 12,237,67,176,92,193,1
6,238,241,193,16,211,58,0,91,33,
176,92,119,35,175,126,222,176
 160 DATA 56,3,119,24,8,126,254,
0,32,2,54,176,33,193,225,16,177,
35,193,16,168,58,3,91,135,135,13
5,111,58,176,92,133
 170 DATA 50,0,91,50,176,92,58,1
,91,50,177,92,225,35,58,4,91,61,
200,60,4,91,195,206,126
 200 LET x=0: LET y=100: LET h=8
: LET w=4: LET a$="Finished"
 210 RANDOMIZE USR 32393
 220 STOP
9999 SAVE "large" LINE 1
```

(continued on page 142)

Example program — listing 2.

```
  10 LET x=0: LET y=175
  20 LET h=4
  25 FOR l=1 TO 5
  30 READ a$
  40 LET w=INT (32/LEN a$)
  50 LET x=INT ((256-(8*w*LEN a$
))/2)
  60 RANDOMIZE USR 32393
  70 LET y=y-8*h
  80 NEXT l
  85 LET y=y+24
  86 READ a$: RANDOMIZE USR 3239
3: STOP
  90 DATA "Program:PLOT","©1983
S.Nicholls","******************
*************","YOUR COMPUTER","
APRIL 1983"," "
```

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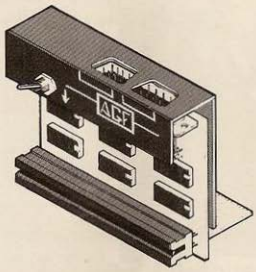

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- ★ Second Joystick facility
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- ★ Free demo program, 'Video Graffiti' + full instructions

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(continued from page 140)

Listing 4.

```
1 FOR a=1 TO 2: NEXT a
2 DIM b$(7)
3 LET c$="w"
4 DIM d(7)
5 LET e=1
6 LET d$(a)=s=1
7 LET R=1
8 LET B=1
9 LET C=1
10 LET D=1
11 LET E=1
12 LET F=1
13 LET G=1
14 LET H=1
15 LET I=1
16 LET J=1
17 LET K=1
18 LET L=1
19 LET M=1
20 LET N=1
21 LET O=1
22 LET P=1
23 LET Q=1
24 LET R=1
25 LET S=1
26 LET T=1
27 LET U=1
28 LET V=1
29 LET W=1
30 LET X=1
31 LET Y=1
32 LET Z=1
33 LET a$="."
34 LET b$="2"
35 LET d$=STRINE=3
36 FOR L=1 TO 10: NEXT L
37 LET a$=a$
38 LET o$(a)=a$
39 LET o$(a)=a$
40 LET P$(a)=1
50 LET P$(a)=1
51 LET a$="."
52 LET a$="0"
53 DIM v$(6)
54 FOR h=1 TO 2: NEXT h
55 FOR w=34 TO 35: NEXT w
56 LET d$="a"
57 LET a$="."
58 FOR x=1 TO 4: NEXT x
59 FOR z=1 TO 9: NEXT z
60 DIM s$(3)
61 DIM r(7)
62 DIM (a$(0.7)
63 DIM b(2)
64 FOR O=1 TO 2: NEXT o
65 LPRINT "DEMO BASIC PROGRAM"
67 LPRINT "
68 LLIST
500 LPRINT ""SCREEN COPY OF A
GOTO"
510 RANDOMIZE USR 31900
515 LPRINT ""
520 COPY
550 LPRINT ""MACHINE CODE DUM
P"
560 LPRINT ""MAY BE LOCATED AN
WHERE IN  AVAILABLE MEMORY"
570 LPRINT "
580 FOR a=31900 TO 32210 STEP 8
610 FOR b=0 TO 7
620 LPRINT TAB b+4;PEEK (a+b);
630 NEXT b: NEXT a: STOP
9999 CLEAR 31659: LOAD ""CODE :
GO TO 1
9999 SAVE "basicvars" LINE 9998:
SAVE "variables"CODE 31900,512
```

Screen copy of listing 4.

```
PN# $()■■NO.()■■NO.■(UORD) NO.

a   b   c   d   e   details
h   v   f   s   b   define
i   j   s   f   c   data
l   o   g   b   d   origin
m   w   d   f   r   print
n   z   m   r   p   help
p
r
s
t
u
v
w
x
y
z
```

Listing 3.

```
83  3   205 155 34  253 54  83
15  62  2   206 1   22  205 107
11  62  3   205 1   22  78  215
215 175 215 178 215 62  78  215
62  78  215 62  143 215 62  38
215 93  35  215 92  40  215 62
41  215 215 62  143 215 62  36 215
62  143 215 62  78  215 62  79
215 62  46  215 62  40  215 62
41  215 62  143 215 62  78  215
62  78  215 215 62  41  215 62
215 62  48  215 62  40  215 62
79  215 62  80  215 62  80  215
62  43  215 62  32  215 62  6
215 62  33  215 62  91  215 36
16  252 6   0   175 33  3   91
119 35  35  198 4   91  249 48
75  98  34  176 92  17  2   91
126 254 126 204 234 204 204 234
40  39  19  19  254 192 40  24
19  19  254 64  40  19  19
254 128 40  19  19  19  254 96
40  6   19  19  24  2   24  32
237 83  0   91  26  254 22  32
38  229 213 116 203 203 1   116
145 244 253 203 1   1   32  91
237 83  0   91  26  1   33  0
33  128 254 1   0   33  0   91
33  16  245 229 229 24  229 195
238 31  195 145 92  145 92  91
1   93  62  32  215 42  0   91
126 62  215 215 126 215 241 215
43  176 98  203 118 33  0   36
94  39  86  94  1   84  187 203
118 32  16  36  126 203 127 32
3   215 24  347 203 127 215 17
8   0   25  24  145 203 126 40
246 17  19  0   85  24  135 0
```

Listing 5.

```
5C00 3E01      LD  A,01
5C02 CD0822    CALL 2208
5C05 ED5B53DF  LD  (17453),DE
5C09 3E82      LD  A,82
5C0B CD8116    CALL 1601
5C0E CD0000    CALL 0000
5CE1 3E82      LD  A,82
5CE3 CD8116    CALL 1601
5CE6 PRINT "PN# $()■■NO.()■■NO.■
(UORD) NO."
5C47 ED5E      LD  E,DE
5C49 3E2C      LD  A,2C
5C4B 218050    LD  HL,5080
5C4F 77        LD  (HL),A
5C50 77        LD  (HL),A
5C51 10FC      DJNZ 5C4E
5C53 0606      LD  B,06
5C54 AF        XOR A
5C55 918358    LD  (HL),B
5C58 77        LD  (HL),A
5C59 23        INC HL
5C5A 23        INC HL
5C5B C604      ADD A,04
5C5D 18F9      DJNZ 5C58
5C5F 2A4B5C    LD  HL,(5C5B)
5C62 228080    LD  (5C80),HL
5C65 110205    LD  DE,5082
5C68 7E        LD  A,(HL)
5C69 FE80      CP  80
5C6B C0        RET NZ
5C6C 5E        LD  E,(HL)
5C6D FE20      CP  20
5C6F 28FB      JR  Z,5C6C
5C70 13        INC DE
5C71 FECD      CP  CD
5C73 2816      JR  Z,5C8B
5C75 13        INC DE
5C76 13        INC DE
5C77 FE40      CP  40
5C79 3812      JR  C,5C8D
5C7B 13        INC DE
5C7C 13        INC DE
5C7D 13        INC DE
5C7E 13        INC DE
5C7F FE40      CP  40
5C81 3812      JR  C,5C95
5C83 13        INC DE
5C84 13        INC DE
5C85 13        INC DE
5C86 13        INC DE
5C87 FE40      CP  40
5C89 3812      JR  C,5C9D
5C8B 13        INC DE
5C8C 13        INC DE
5C8D 1802      JR  5C91
5C8F 1802      JR  5C93
5C91 ED53005B  LD  (5B00),DE
5C94 16        LD  D,16
5C95 FE18      CP  18
5C97 38E8      JRNZ 5C81
5C99 E5        PUSH HL
5C9A DF        RST 18
5C9B 78        HALT
5C9C FDCB01BE  RES 5,(IY+01)
5CA0 38FB      JR  C,5C9D
5CA2 FDCB01AE  RES 5,(IY+01)
5CA6 CD0A12    CALL 1200
5CA9 CD0000    CALL 0000
5CAC 0D        LD  D,D
5CAD 21025B    LD  HL,5B02
5CB0 3B        DEC HL
5CB1 7E        LD  A,(HL)
5CB2 FE21      CP  21
5CB4 2201      JR  NZ,5CB7
5CB6 34        INC (HL)
5CB7 23        INC HL
5CB8 20FB      DJNZ 5CB5
5CBA 21025B    LD  HL,5B02
5CBD 7E        LD  A,(HL)
5CBE 07        RLCA
5CBF 3201      JR  NZ,5CC2
5CC1 34        INC (HL)
5CC2 23        INC HL
5CC3 20FB      DJNZ 5CC0
5CC5 21025B    LD  HL,5B02
5CC8 7E        LD  A,(HL)
5CC9 07        RLCA
5CCA 3E16      LD  A,16
5CCC 02        RST 10
5CCD 3B085B    LD  HL,(5B08)
5CD0 7E        LD  A,(HL)
5CD1 34        INC (HL)
5CD2 02        RST 10
5CD3 23        INC HL
5CD4 7E        LD  A,(HL)
5CD5 02        RST 10
5CD6 23        INC HL
5CD7 02        RST 10
5CD8 F1        POP AF
5CD9 D7        RST 10
5CDA C656      ADD A,56
5CDC F5        PUSH AF
5CDD 3E02      LD  A,02
5CDF CD0116    CALL 1601
5CE2 3E16      LD  A,16
5CE4 02        RST 10
5CE5 2B        DEC HL
5CE6 7E        LD  A,(HL)
5CE7 02        RST 10
5CE8 2B        DEC HL
5CE9 7E        LD  A,(HL)
5CEA 02        RST 10
5CEB 2B        DEC HL
5CEC 7E        LD  A,(HL)
5CED 02        RST 10
5CEE 3B085C    LD  HL,(5C08)
5CF1 CB86      RES 0,(HL)
5CF3 23        INC HL
5CF4 23        INC HL
5CF5 23        INC HL
5CF6 7E        LD  A,(HL)
5CF7 1B        DEC DE
5CF8 1887      JR  5C81
5CFA 2A4B5C    LD  HL,(5C4B)
5CFD 2512      DEC H
5CFF 22        INC HL
5D00 7C        LD  A,(HL)
5D01 CB7F      BIT 7,A
5D03 2003      JR  NZ,5D08
5D05 D7        RST 10
5D06 18F7      JR  5CFF
5D08 E67F      AND 7F
5D0A D7        RST 10
5D0B 110800    LD  DE,0008
5D0E 19        ADD HL,DE
5D0F 1891      JR  5D82
5D11 2A7E      LD  HL,(5E7E)
5D14 2B        DEC HL
5D15 111300    LD  DE,0013
5D18 19        ADD HL,DE
5D19 1887      JR  5D82
5D1B 3D        DEC A
5D1C 2003      JR  NZ,5D21
5D1E 3E20      LD  A,20
5D20 18E6      JR  5D08
5D21 FE01      CP  01
5D23 2003      JR  NZ,5D28
5D25 3E2C      LD  A,2C
5D27 18E1      JR  5D0A
5D29 FE02      CP  02
5D2B 2003      JR  NZ,5D30
5D2D 3E2D      LD  A,2D
5D2F 18DB      JR  5D0C
5D31 FE03      CP  03
5D33 2003      JR  NZ,5D38
5D35 3E2E      LD  A,2E
5D37 18D5      JR  5D0E
5D39 FE04      CP  04
5D3B 2003      JR  NZ,5D40
5D3D 3E2F      LD  A,2F
5D3F 18CF      JR  5D10
5D41 FE05      CP  05
5D43 2003      JR  NZ,5D48
5D45 3E30      LD  A,30
5D47 18C9      JR  5D12
5D49 FE06      CP  06
5D4B 2003      JR  NZ,5D50
5D4D 3E31      LD  A,31
5D4F 18C3      JR  5D14
5D51 FE07      CP  07
5D53 2003      JR  NZ,5D58
5D55 3E32      LD  A,32
5D57 18BD      JR  5D16
5D59 FE08      CP  08
5D5B 2003      JR  NZ,5D60
5D5D 3E33      LD  A,33
5D5F 18B7      JR  5D18
5D61 FE09      CP  09
5D63 2003      JR  NZ,5D68
5D65 3E34      LD  A,34
5D67 18B1      JR  5D1A
5D69 FE0A      CP  0A
5D6B 2003      JR  NZ,5D70
5D6D 3E35      LD  A,35
5D6F 18AB      JR  5D1C
5D71 FE0B      CP  0B
5D73 2003      JR  NZ,5D78
5D75 3E36      LD  A,36
5D77 18A5      JR  5D1E
5D79 FE0C      CP  0C
5D7B 2003      JR  NZ,5D80
5D7D 3E37      LD  A,37
5D7F 189F      JR  5D20
5D81 FE0D      CP  0D
5D83 2003      JR  NZ,5D88
5D85 3E38      LD  A,38
5D87 1899      JR  5D22
5D89 FE0E      CP  0E
5D8B 2003      JR  NZ,5D90
5D8D 3E39      LD  A,39
5D8F 1893      JR  5D24
5D91 FE0F      CP  0F
5D93 2003      JR  NZ,5D98
5D95 3E2A      LD  A,2A
5D97 188D      JR  5D26
5D99 FE10      CP  10
5D9B 2003      JR  NZ,5DA0
5D9D 3E2B      LD  A,2B
5D9F 1887      JR  5D28
5DA1 FE11      CP  11
5DA3 2003      JR  NZ,5DA8
5DA5 3E2C      LD  A,2C
5DA7 1881      JR  5D2A
5DA9 FE12      CP  12
5DAB 2003      JR  NZ,5DB0
5DAD 3E2D      LD  A,2D
5DAF 187B      JR  5D2C
5DB1 FE13      CP  13
5DB3 2003      JR  NZ,5DB8
5DB5 3E2E      LD  A,2E
5DB7 1875      JR  5D2E
5DB9 FE14      CP  14
5DBB 2003      JR  NZ,5DC0
5DBD 3E2F      LD  A,2F
5DBF 186F      JR  5D30
5DC1 FE15      CP  15
5DC3 2003      JR  NZ,5DC8
5DC5 3E30      LD  A,30
5DC7 1869      JR  5D32
5DC9 FE16      CP  16
5DCB 2003      JR  NZ,5DD0
5DCD 3E31      LD  A,31
5DCF 1863      JR  5D34
5DD1 FE17      CP  17
5DD3 2003      JR  NZ,5DD8
5DD5 3E32      LD  A,32
5DD7 185D      JR  5D36
5DD9 FE18      CP  18
5DDB 2003      JR  NZ,5DE0
5DDD 3E33      LD  A,33
5DDF 1857      JR  5D38
5DE1 FE19      CP  19
5DE3 2003      JR  NZ,5DE8
5DE5 3E34      LD  A,34
5DE7 1851      JR  5D3A
5DE9 FE1A      CP  1A
5DEB 2003      JR  NZ,5DF0
5DED 3E35      LD  A,35
5DEF 184B      JR  5D3C
5DF1 FE1B      CP  1B
5DF3 2003      JR  NZ,5DF8
5DF5 3E36      LD  A,36
5DF7 1845      JR  5D3E
5DF9 FE1C      CP  1C
5DFB 2003      JR  NZ,5E00
5DFD 3E37      LD  A,37
5DFF 183F      JR  5D40
5E01 FE1D      CP  1D
5E03 2003      JR  NZ,5E08
5E05 3E38      LD  A,38
5E07 1839      JR  5D42
5E09 FE1E      CP  1E
5E0B 2003      JR  NZ,5E10
5E0D 3E39      LD  A,39
5E0F 1833      JR  5D44
5E11 FE1F      CP  1F
5E13 2003      JR  NZ,5E18
5E15 3E2A      LD  A,2A
5E17 182D      JR  5D46
5E19 FE20      CP  20
5E1B 2003      JR  NZ,5E20
5E1D 3E2B      LD  A,2B
5E1F 1827      JR  5D48
5E21 FE21      CP  21
5E23 2003      JR  NZ,5E28
5E25 3E2C      LD  A,2C
5E27 1821      JR  5D4A
5E29 FE22      CP  22
5E2B 2003      JR  NZ,5E30
5E2D 3E2D      LD  A,2D
5E2F 181B      JR  5D4C
5E31 FE23      CP  23
5E33 2003      JR  NZ,5E38
5E35 3E2E      LD  A,2E
5E37 1815      JR  5D4E
5E39 FE24      CP  24
5E3B 2003      JR  NZ,5E40
5E3D 3E2F      LD  A,2F
5E3F 180F      JR  5D50
5E41 FE25      CP  25
5E43 2003      JR  NZ,5E48
5E45 3E30      LD  A,30
5E47 1809      JR  5D52
5E49 FE26      CP  26
5E4B 2003      JR  NZ,5E50
5E4D 3E31      LD  A,31
5E4F 1803      JR  5D54
5E51 FE27      CP  27
5E53 2003      JR  NZ,5E58
5E55 3E32      LD  A,32
5E57 18FD      JR  5D56
5E59 FE28      CP  28
5E5B 2003      JR  NZ,5E60
5E5D 3E33      LD  A,33
5E5F 18F7      JR  5D58
5E61 FE29      CP  29
5E63 2003      JR  NZ,5E68
5E65 3E34      LD  A,34
5E67 18F1      JR  5D5A
5E69 FE2A      CP  2A
5E6B 2003      JR  NZ,5E70
5E6D 3E35      LD  A,35
5E6F 18EB      JR  5D5C
5E71 FE2B      CP  2B
5E73 2003      JR  NZ,5E78
5E75 3E36      LD  A,36
5E77 18E5      JR  5D5E
5E79 FE2C      CP  2C
5E7B 2003      JR  NZ,5E80
5E7D 3E37      LD  A,37
5E7F 18DF      JR  5D60
5E81 FE2D      CP  2D
5E83 2003      JR  NZ,5E88
5E85 3E38      LD  A,38
5E87 18D9      JR  5D62
5E89 FE2E      CP  2E
5E8B 2003      JR  NZ,5E90
5E8D 3E39      LD  A,39
5E8F 18D3      JR  5D64
5E91 FE2F      CP  2F
5E93 2003      JR  NZ,5E98
5E95 3E2A      LD  A,2A
5E97 18CD      JR  5D66
5E99 FE30      CP  30
5E9B 2003      JR  NZ,5EA0
5E9D 3E2B      LD  A,2B
5E9F 18C7      JR  5D68
5EA1 FE31      CP  31
5EA3 2003      JR  NZ,5EA8
5EA5 3E2C      LD  A,2C
5EA7 18C1      JR  5D6A
5EA9 FE32      CP  32
5EAB 2003      JR  NZ,5EB0
5EAD 3E2D      LD  A,2D
5EAF 18BB      JR  5D6C
5EB1 FE33      CP  33
5EB3 2003      JR  NZ,5EB8
5EB5 3E2E      LD  A,2E
5EB7 18B5      JR  5D6E
5EB9 FE34      CP  34
5EBB 2003      JR  NZ,5EC0
5EBD 3E2F      LD  A,2F
5EBF 18AF      JR  5D70
5EC1 FE35      CP  35
5EC3 2003      JR  NZ,5EC8
5EC5 3E30      LD  A,30
5EC7 18A9      JR  5D72
5EC9 FE36      CP  36
5ECB 2003      JR  NZ,5ED0
5ECD 3E31      LD  A,31
5ECF 18A3      JR  5D74
5ED1 FE37      CP  37
5ED3 2003      JR  NZ,5ED8
5ED5 3E32      LD  A,32
5ED7 189D      JR  5D76
5ED9 FE38      CP  38
5EDB 2003      JR  NZ,5EE0
5EDD 3E33      LD  A,33
5EDF 1897      JR  5D78
5EE1 FE39      CP  39
5EE3 2003      JR  NZ,5EE8
5EE5 3E34      LD  A,34
5EE7 1891      JR  5D7A
5EE9 FE3A      CP  3A
5EEB 2003      JR  NZ,5EF0
5EED 3E35      LD  A,35
5EEF 188B      JR  5D7C
5EF1 FE3B      CP  3B
5EF3 2003      JR  NZ,5EF8
5EF5 3E36      LD  A,36
5EF7 1885      JR  5D7E
5EF9 FE3C      CP  3C
5EFB 2003      JR  NZ,5F00
5EFD 3E37      LD  A,37
5EFF 187F      JR  5D80
5F01 FE3D      CP  3D
5F03 2003      JR  NZ,5F08
5F05 3E38      LD  A,38
5F07 1879      JR  5D82
5F09 FE3E      CP  3E
5F0B 2003      JR  NZ,5F10
5F0D 3E39      LD  A,39
5F0F 1873      JR  5D84
5F11 FE3F      CP  3F
5F13 2003      JR  NZ,5F18
5F15 3E2A      LD  A,2A
5F17 186D      JR  5D86
5F19 FE40      CP  40
5F1B 2003      JR  NZ,5F20
5F1D 3E2B      LD  A,2B
5F1F 1867      JR  5D88
5F21 FE41      CP  41
5F23 2003      JR  NZ,5F28
5F25 3E2C      LD  A,2C
5F27 1861      JR  5D8A
5F29 FE42      CP  42
5F2B 2003      JR  NZ,5F30
5F2D 3E2D      LD  A,2D
5F2F 185B      JR  5D8C
5F31 FE43      CP  43
5F33 2003      JR  NZ,5F38
5F35 3E2E      LD  A,2E
5F37 1855      JR  5D8E
5F39 FE44      CP  44
5F3B 2003      JR  NZ,5F40
5F3D 3E2F      LD  A,2F
5F3F 184F      JR  5D90
5F41 FE45      CP  45
5F43 2003      JR  NZ,5F48
5F45 3E30      LD  A,30
5F47 1849      JR  5D92
5F49 FE46      CP  46
5F4B 2003      JR  NZ,5F50
5F4D 3E31      LD  A,31
5F4F 1843      JR  5D94
5F51 FE47      CP  47
5F53 2003      JR  NZ,5F58
5F55 3E32      LD  A,32
5F57 183D      JR  5D96
5F59 FE48      CP  48
5F5B 2003      JR  NZ,5F60
5F5D 3E33      LD  A,33
5F5F 1837      JR  5D98
5F61 FE49      CP  49
5F63 2003      JR  NZ,5F68
5F65 3E34      LD  A,34
5F67 1831      JR  5D9A
5F69 FE4A      CP  4A
5F6B 2003      JR  NZ,5F70
5F6D 3E35      LD  A,35
5F6F 182B      JR  5D9C
5F71 FE4B      CP  4B
5F73 2003      JR  NZ,5F78
5F75 3E36      LD  A,36
5F77 1825      JR  5D9E
5F79 FE4C      CP  4C
5F7B 2003      JR  NZ,5F80
5F7D 3E37      LD  A,37
5F7F 181F      JR  5DA0
5F81 FE4D      CP  4D
5F83 2003      JR  NZ,5F88
5F85 3E38      LD  A,38
5F87 1819      JR  5DA2
5F89 FE4E      CP  4E
5F8B 2003      JR  NZ,5F90
5F8D 3E39      LD  A,39
5F8F 1813      JR  5DA4
5F91 FE4F      CP  4F
5F93 2003      JR  NZ,5F98
5F95 3E2A      LD  A,2A
5F97 180D      JR  5DA6
5F99 FE50      CP  50
5F9B 2003      JR  NZ,5FA0
5F9D 3E2B      LD  A,2B
5F9F 1807      JR  5DA8
5FA1 FE51      CP  51
5FA3 2003      JR  NZ,5FA8
5FA5 3E2C      LD  A,2C
5FA7 1801      JR  5DAA
5FA9 FE52      CP  52
5FAB 2003      JR  NZ,5FB0
5FAD 3E2D      LD  A,2D
5FAF 18FB      JR  5DAC
5FB1 FE53      CP  53
5FB3 2003      JR  NZ,5FB8
5FB5 3E2E      LD  A,2E
5FB7 18F5      JR  5DAE
5FB9 FE54      CP  54
5FBB 2003      JR  NZ,5FC0
5FBD 3E2F      LD  A,2F
5FBF 18EF      JR  5DB0
5FC1 FE55      CP  55
5FC3 2003      JR  NZ,5FC8
5FC5 3E30      LD  A,30
5FC7 18E9      JR  5DB2
5FC9 FE56      CP  56
5FCB 2003      JR  NZ,5FD0
5FCD 3E31      LD  A,31
5FCF 18E3      JR  5DB4
5FD1 FE57      CP  57
5FD3 2003      JR  NZ,5FD8
5FD5 3E32      LD  A,32
5FD7 18DD      JR  5DB6
5FD9 FE58      CP  58
5FDB 2003      JR  NZ,5FE0
5FDD 3E33      LD  A,33
5FDF 18D7      JR  5DB8
5FE1 FE59      CP  59
5FE3 2003      JR  NZ,5FE8
5FE5 3E34      LD  A,34
5FE7 18D1      JR  5DBA
5FE9 FE5A      CP  5A
5FEB 2003      JR  NZ,5FF0
5FED 3E35      LD  A,35
5FEF 18CB      JR  5DBC
5FF1 FE5B      CP  5B
5FF3 2003      JR  NZ,5FF8
5FF5 3E36      LD  A,36
5FF7 18C5      JR  5DBE
5FF9 FE5C      CP  5C
5FFB 2003      JR  NZ,6000
5FFD 3E37      LD  A,37
6000 18BF      JR  5DC0
6002 FE5D      CP  5D
6004 2003      JR  NZ,6009
6006 3E38      LD  A,38
6008 18B9      JR  5DC2
600A FE5E      CP  5E
600C 2003      JR  NZ,6011
600E 3E39      LD  A,39
6010 18B3      JR  5DC4
6012 FE5F      CP  5F
6014 2003      JR  NZ,6019
6016 3E2A      LD  A,2A
6018 18AD      JR  5DC6
601A FE60      CP  60
601C 2003      JR  NZ,6021
601E 3E2B      LD  A,2B
6020 18A7      JR  5DC8
6022 FE61      CP  61
6024 2003      JR  NZ,6029
6026 3E2C      LD  A,2C
6028 18A1      JR  5DCA
602A FE62      CP  62
602C 2003      JR  NZ,6031
602E 3E2D      LD  A,2D
6030 189B      JR  5DCC
6032 FE63      CP  63
6034 2003      JR  NZ,6039
6036 3E2E      LD  A,2E
6038 1895      JR  5DCE
603A FE64      CP  64
603C 2003      JR  NZ,6041
603E 3E2F      LD  A,2F
6040 188F      JR  5DD0
6042 FE65      CP  65
6044 2003      JR  NZ,6049
6046 3E30      LD  A,30
6048 1889      JR  5DD2
604A FE66      CP  66
604C 2003      JR  NZ,6051
604E 3E31      LD  A,31
6050 1883      JR  5DD4
6052 FE67      CP  67
6054 2003      JR  NZ,6059
6056 3E32      LD  A,32
6058 187D      JR  5DD6
605A FE68      CP  68
605C 2003      JR  NZ,6061
605E 3E33      LD  A,33
6060 1877      JR  5DD8
6062 FE69      CP  69
6064 2003      JR  NZ,6069
6066 3E34      LD  A,34
6068 1871      JR  5DDA
606A FE6A      CP  6A
606C 2003      JR  NZ,6071
606E 3E35      LD  A,35
6070 186B      JR  5DDC
6072 FE6B      CP  6B
6074 2003      JR  NZ,6079
6076 3E36      LD  A,36
6078 1865      JR  5DDE
607A FE6C      CP  6C
607C 2003      JR  NZ,6081
607E 3E37      LD  A,37
6080 185F      JR  5DE0
6082 FE6D      CP  6D
6084 2003      JR  NZ,6089
6086 3E38      LD  A,38
6088 1859      JR  5DE2
608A FE6E      CP  6E
608C 2003      JR  NZ,6091
608E 3E39      LD  A,39
6090 1853      JR  5DE4
6092 FE6F      CP  6F
6094 2003      JR  NZ,6099
6096 3E2A      LD  A,2A
6098 184D      JR  5DE6
609A FE70      CP  70
609C 2003      JR  NZ,60A1
609E 3E2B      LD  A,2B
60A0 1847      JR  5DE8
60A2 FE71      CP  71
60A4 2003      JR  NZ,60A9
60A6 3E2C      LD  A,2C
60A8 1841      JR  5DEA
60AA FE72      CP  72
60AC 2003      JR  NZ,60B1
60AE 3E2D      LD  A,2D
60B0 183B      JR  5DEC
60B2 FE73      CP  73
60B4 2003      JR  NZ,60B9
60B6 3E2E      LD  A,2E
60B8 1835      JR  5DEE
60BA FE74      CP  74
60BC 2003      JR  NZ,60C1
60BE 3E2F      LD  A,2F
60C0 182F      JR  5DF0
60C2 FE75      CP  75
60C4 2003      JR  NZ,60C9
60C6 3E30      LD  A,30
60C8 1829      JR  5DF2
60CA FE76      CP  76
60CC 2003      JR  NZ,60D1
60CE 3E31      LD  A,31
60D0 1823      JR  5DF4
60D2 FE77      CP  77
60D4 2003      JR  NZ,60D9
60D6 3E32      LD  A,32
60D8 181D      JR  5DF6
60DA FE78      CP  78
60DC 2003      JR  NZ,60E1
60DE 3E33      LD  A,33
60E0 1817      JR  5DF8
60E2 FE79      CP  79
60E4 2003      JR  NZ,60E9
60E6 3E34      LD  A,34
60E8 1811      JR  5DFA
60EA FE7A      CP  7A
60EC 2003      JR  NZ,60F1
60EE 3E35      LD  A,35
60F0 180B      JR  5DFC
60F2 FE7B      CP  7B
60F4 2003      JR  NZ,60F9
60F6 3E36      LD  A,36
60F8 1805      JR  5DFE
60FA FE7C      CP  7C
60FC 2003      JR  NZ,6101
60FE 3E37      LD  A,37
6100 1800      JR  5E00
6102 FE7D      CP  7D
6104 2003      JR  NZ,6109
6106 3E38      LD  A,38
6108 18FA      JR  5E02
610A FE7E      CP  7E
610C 2003      JR  NZ,6111
610E 3E39      LD  A,39
6110 18F4      JR  5E04
6112 FE7F      CP  7F
6114 2003      JR  NZ,6119
6116 3E2A      LD  A,2A
6118 18EE      JR  5E06
611A FE80      CP  80
611C 2003      JR  NZ,6121
611E 3E2B      LD  A,2B
6120 18E8      JR  5E08
6122 FE81      CP  81
6124 2003      JR  NZ,6129
6126 3E2C      LD  A,2C
6128 18E2      JR  5E0A
612A FE82      CP  82
612C 2003      JR  NZ,6131
612E 3E2D      LD  A,2D
6130 18DC      JR  5E0C
6132 FE83      CP  83
6134 2003      JR  NZ,6139
6136 3E2E      LD  A,2E
6138 18D6      JR  5E0E
613A FE84      CP  84
613C 2003      JR  NZ,6141
613E 3E2F      LD  A,2F
6140 18D0      JR  5E10
6142 FE85      CP  85
6144 2003      JR  NZ,6149
6146 3E30      LD  A,30
6148 18CA      JR  5E12
614A FE86      CP  86
614C 2003      JR  NZ,6151
614E 3E31      LD  A,31
6150 18C4      JR  5E14
6152 FE87      CP  87
6154 2003      JR  NZ,6159
6156 3E32      LD  A,32
6158 18BE      JR  5E16
615A FE88      CP  88
615C 2003      JR  NZ,6161
615E 3E33      LD  A,33
6160 18B8      JR  5E18
6162 FE89      CP  89
6164 2003      JR  NZ,6169
6166 3E34      LD  A,34
6168 18B2      JR  5E1A
616A FE8A      CP  8A
616C 2003      JR  NZ,6171
616E 3E35      LD  A,35
6170 18AC      JR  5E1C
6172 FE8B      CP  8B
6174 2003      JR  NZ,6179
6176 3E36      LD  A,36
6178 18A6      JR  5E1E
617A FE8C      CP  8C
617C 2003      JR  NZ,6181
617E 3E37      LD  A,37
6180 18A0      JR  5E20
6182 FE8D      CP  8D
6184 2003      JR  NZ,6189
6186 3E38      LD  A,38
6188 189A      JR  5E22
618A FE8E      CP  8E
618C 2003      JR  NZ,6191
618E 3E39      LD  A,39
6190 1894      JR  5E24
6192 FE8F      CP  8F
6194 2003      JR  NZ,6199
6196 3E2A      LD  A,2A
6198 188E      JR  5E26
619A FE90      CP  90
619C 2003      JR  NZ,61A1
619E 3E2B      LD  A,2B
61A0 1888      JR  5E28
61A2 FE91      CP  91
61A4 2003      JR  NZ,61A9
61A6 3E2C      LD  A,2C
61A8 1882      JR  5E2A
61AA FE92      CP  92
61AC 2003      JR  NZ,61B1
61AE 3E2D      LD  A,2D
61B0 187C      JR  5E2C
61B2 FE93      CP  93
61B4 2003      JR  NZ,61B9
61B6 3E2E      LD  A,2E
61B8 1876      JR  5E2E
61BA FE94      CP  94
61BC 2003      JR  NZ,61C1
61BE 3E2F      LD  A,2F
61C0 1870      JR  5E30
61C2 FE95      CP  95
61C4 2003      JR  NZ,61C9
61C6 3E30      LD  A,30
61C8 186A      JR  5E32
61CA FE96      CP  96
61CC 2003      JR  NZ,61D1
61CE 3E31      LD  A,31
61D0 1864      JR  5E34
61D2 FE97      CP  97
61D4 2003      JR  NZ,61D9
61D6 3E32      LD  A,32
61D8 185E      JR  5E36
61DA FE98      CP  98
61DC 2003      JR  NZ,61E1
61DE 3E33      LD  A,33
61E0 1858      JR  5E38
61E2 FE99      CP  99
61E4 2003      JR  NZ,61E9
61E6 3E34      LD  A,34
61E8 1852      JR  5E3A
61EA FE9A      CP  9A
61EC 2003      JR  NZ,61F1
61EE 3E35      LD  A,35
61F0 184C      JR  5E3C
61F2 FE9B      CP  9B
61F4 2003      JR  NZ,61F9
61F6 3E36      LD  A,36
61F8 1846      JR  5E3E
61FA FE9C      CP  9C
61FC 2003      JR  NZ,6201
61FE 3E37      LD  A,37
6200 1840      JR  5E40
6202 FE9D      CP  9D
6204 2003      JR  NZ,6209
6206 3E38      LD  A,38
6208 183A      JR  5E42
620A FE9E      CP  9E
620C 2003      JR  NZ,6211
620E 3E39      LD  A,39
6210 1834      JR  5E44
6212 FE9F      CP  9F
6214 2003      JR  NZ,6219
6216 3E2A      LD  A,2A
6218 182E      JR  5E46
621A FEA0      CP  A0
621C 2003      JR  NZ,6221
621E 3E2B      LD  A,2B
6220 1828      JR  5E48
6222 FEA1      CP  A1
6224 2003      JR  NZ,6229
6226 3E2C      LD  A,2C
6228 1822      JR  5E4A
622A FEA2      CP  A2
622C 2003      JR  NZ,6231
622E 3E2D      LD  A,2D
6230 181C      JR  5E4C
6232 FEA3      CP  A3
6234 2003      JR  NZ,6239
6236 3E2E      LD  A,2E
6238 1816      JR  5E4E
623A FEA4      CP  A4
623C 2003      JR  NZ,6241
623E 3E2F      LD  A,2F
6240 1810      JR  5E50
6242 FEA5      CP  A5
6244 2003      JR  NZ,6249
6246 3E30      LD  A,30
6248 180A      JR  5E52
624A FEA6      CP  A6
624C 2003      JR  NZ,6251
624E 3E31      LD  A,31
6250 1804      JR  5E54
6252 FEA7      CP  A7
6254 2003      JR  NZ,6259
6256 3E32      LD  A,32
6258 18FE      JR  5E56
625A FEA8      CP  A8
625C 2003      JR  NZ,6261
625E 3E33      LD  A,33
6260 18F8      JR  5E58
6262 FEA9      CP  A9
6264 2003      JR  NZ,6269
6266 3E34      LD  A,34
6268 18F2      JR  5E5A
626A FEAA      CP  AA
626C 2003      JR  NZ,6271
626E 3E35      LD  A,35
6270 18EC      JR  5E5C
6272 FEAB      CP  AB
6274 2003      JR  NZ,6279
6276 3E36      LD  A,36
6278 18E6      JR  5E5E
627A FEAC      CP  AC
627C 2003      JR  NZ,6281
627E 3E37      LD  A,37
6280 18E0      JR  5E60
6282 FEAD      CP  AD
6284 2003      JR  NZ,6289
6286 3E38      LD  A,38
6288 18DA      JR  5E62
628A FEAE      CP  AE
628C 2003      JR  NZ,6291
628E 3E39      LD  A,39
6290 18D4      JR  5E64
6292 FEAF      CP  AF
6294 2003      JR  NZ,6299
6296 3E2A      LD  A,2A
6298 18CE      JR  5E66
629A FEB0      CP  B0
629C 2003      JR  NZ,62A1
629E 3E2B      LD  A,2B
62A0 18C8      JR  5E68
62A2 FEB1      CP  B1
62A4 2003      JR  NZ,62A9
62A6 3E2C      LD  A,2C
62A8 18C2      JR  5E6A
62AA FEB2      CP  B2
62AC 2003      JR  NZ,62B1
62AE 3E2D      LD  A,2D
62B0 18BC      JR  5E6C
62B2 FEB3      CP  B3
62B4 2003      JR  NZ,62B9
62B6 3E2E      LD  A,2E
62B8 18B6      JR  5E6E
62BA FEB4      CP  B4
62BC 2003      JR  NZ,62C1
62BE 3E2F      LD  A,2F
62C0 18B0      JR  5E70
62C2 FEB5      CP  B5
62C4 2003      JR  NZ,62C9
62C6 3E30      LD  A,30
62C8 18AA      JR  5E72
62CA FEB6      CP  B6
62CC 2003      JR  NZ,62D1
62CE 3E31      LD  A,31
62D0 18A4      JR  5E74
62D2 FEB7      CP  B7
62D4 2003      JR  NZ,62D9
62D6 3E32      LD  A,32
62D8 189E      JR  5E76
62DA FEB8      CP  B8
62DC 2003      JR  NZ,62E1
62DE 3E33      LD  A,33
62E0 1898      JR  5E78
62E2 FEB9      CP  B9
62E4 2003      JR  NZ,62E9
62E6 3E34      LD  A,34
62E8 1892      JR  5E7A
62EA FEBA      CP  BA
62EC 2003      JR  NZ,62F1
62EE 3E35      LD  A,35
62F0 188C      JR  5E7C
62F2 FEBB      CP  BB
62F4 2003      JR  NZ,62F9
62F6 3E36      LD  A,36
62F8 1886      JR  5E7E
62FA FEBC      CP  BC
62FC 2003      JR  NZ,6301
62FE 3E37      LD  A,37
6300 1880      JR  5E80
6302 FEBD      CP  BD
6304 2003      JR  NZ,6309
6306 3E38      LD  A,38
6308 187A      JR  5E82
630A FEBE      CP  BE
630C 2003      JR  NZ,6311
630E 3E39      LD  A,39
6310 1874      JR  5E84
6312 FEBF      CP  BF
6314 2003      JR  NZ,6319
6316 3E2A      LD  A,2A
6318 186E      JR  5E86
631A FEC0      CP  C0
631C 2003      JR  NZ,6321
631E 3E2B      LD  A,2B
6320 1868      JR  5E88
6322 FEC1      CP  C1
6324 2003      JR  NZ,6329
6326 3E2C      LD  A,2C
6328 1862      JR  5E8A
632A FEC2      CP  C2
632C 2003      JR  NZ,6331
632E 3E2D      LD  A,2D
6330 185C      JR  5E8C
6332
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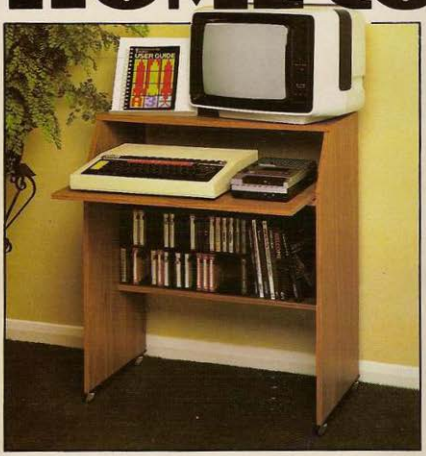

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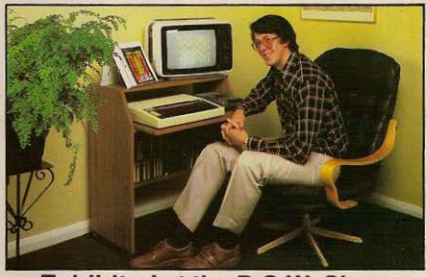

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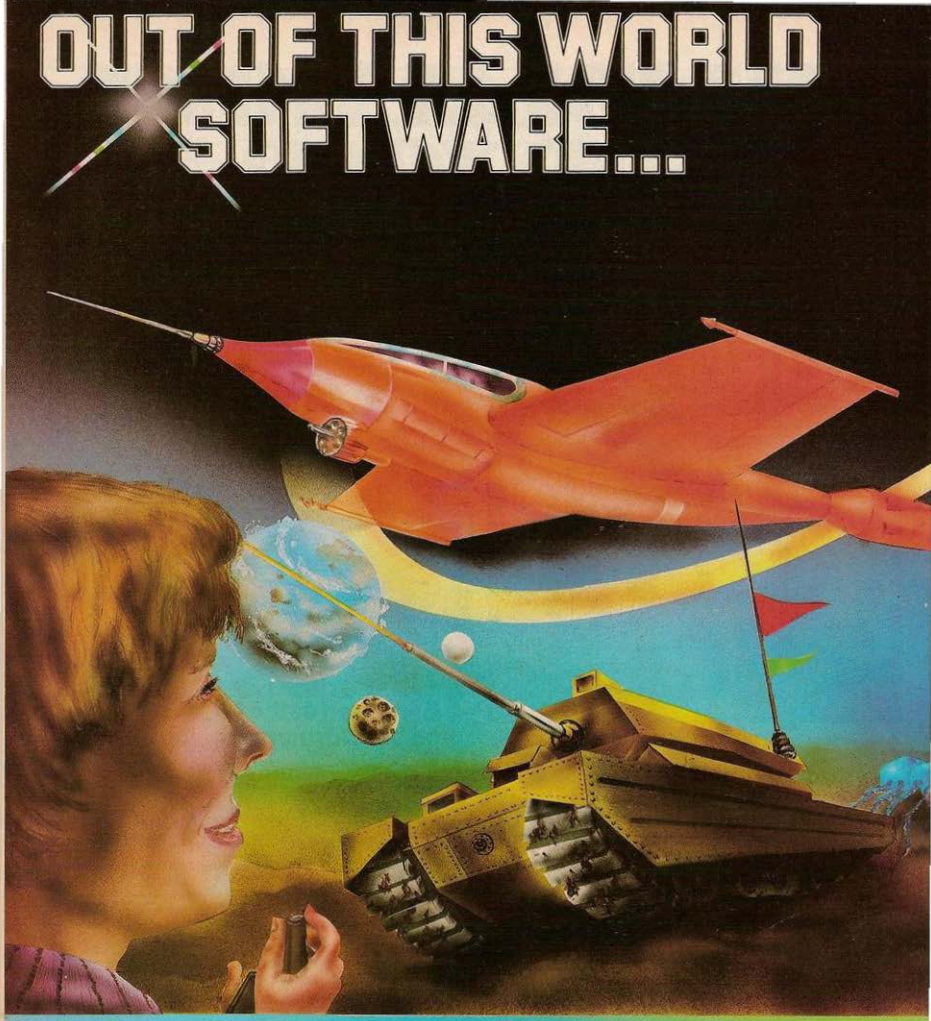

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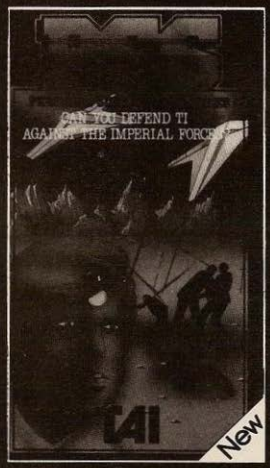
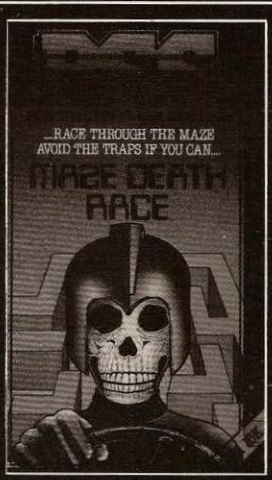


Tai

In any other time or galaxy, the dust ball world called Tai would have been quite unimportant. TIMES CHANGE.... Now it is the last remaining out post between the advancing Imperial Fleet and the main planets of the Dorfian system Unless the Imperial Forces can be held off until the Republican battle fleet arrives, an entire civiliz ation will be betrayed.... You have been chosen to defend Tai, the Galactic future depends on you....

ZX81 16K £4·95



Maze Death Race

Drive through a giant maze, 9 times the size of the screen, picking up points as you go – but watch out for the the other cars, rocks oil and ice. Superb machine code game. Highly recomended.

SPECTRUM 48K £4·95
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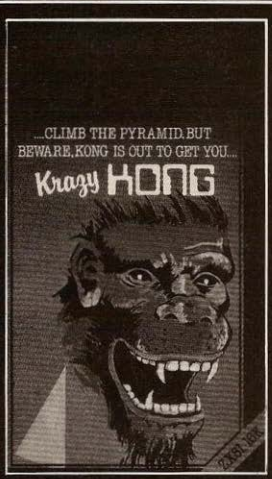
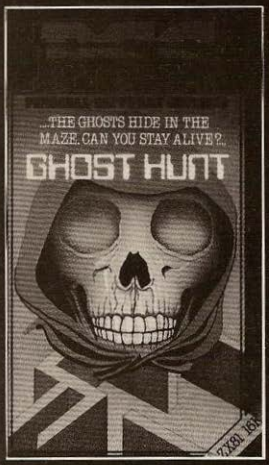


Krazy Kong

All machine code version of the popular arcade game. This program has all the features of the original and is every bit as fast. 3 different screens make it difficult to beat.

ZX81 16K £3·95

the ZX81 16K and Spectrum



Ghost Hunt

Gobble your way through a maze - Ghosts, power pills etc. All machine code. Super fast action.

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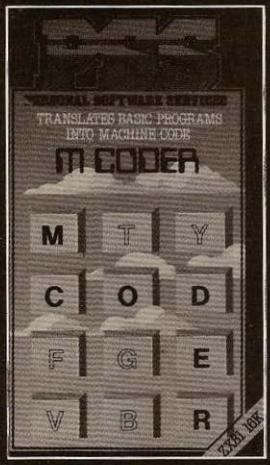

M Coder

Quite simply the most flexible integer compiler available today for either the 16K ZX81 or the Spectrum 16K/48K. M Coder will translate 95% of all non-string basic. The ZX81 version is just over 2K, The Spectrum version just over 3K.
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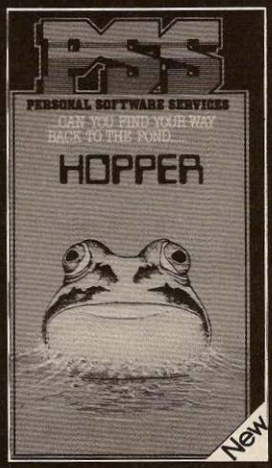
SPECTRUM 16K-48K £8·95
ZX81 16K £7·95



Hopper

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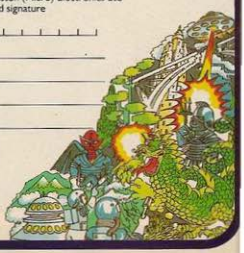

BASIC DICTIONARY

This dictionary, compiled by Tony Edwards, will explain the function of common Basic words as used in popular machines, enabling you to work out your own machine's equivalent. A useful complement to our recent series on Basic dialect translation.

BASIC DICTIONARY

@ **(at)** Used as an abbreviation for AT. On some computers

<shift> @

will freeze execution until another key is pressed.

(hash) Used as a flag to indicate double precision variables. The BBC Micro uses the hash sign to indicate an immediate operation in assembler. This sign is also used with the meaning "number" when referring to peripherals.

CLOAD # 1

will load from peripheral device number 1. Also used to represent "not equal to".

$ **(dollar)** An ANSI standard symbol indicating string variable. It is often used to indicate string functions also.

! **(exclamation mark)** Used as a flag to indicate single precision variables. Its use is usually optional as variables default to single precision. Some interpreters use the exclamation mark as an abbreviation for Remark.

% **(per cent)** A flag used to indicate integer variables. It is also used in connection with a Print Using statement to indicate the output is unprintable.

? **(question)** A common abbreviation for PRINT.

/ **(back slash)** An operator used to allow multiple statements on a single line. It is also used as an erase indicator when correcting typing errors.

* **(asterisk)** An alternative for the multiplication operator. It is also used on some computers as the logical AND operator. The BBC Micro uses it to express the binary multiplication of integers and reals.

** **(double asterisk)** An alternative for the exponentiation operator.

(circumflex) An exponentiation operator

+ **(plus)** The arithmetical addition operator. Some computers use this symbol in place of the logical OR so care must be exercised with such statements as "IF (A=0) + (B=0)" which will be satisfied if either A or B is equal to 0.

BASIC DICTION.

This symbol is also used to indicate concatenation of strings.

- **(minus)** The arithmetic subtraction operator, also used as a negation operator.

/ **(slash)** The ANSI standard division operator.

& **(ampersand)** Widely used as a suffix to indicate hexadecimal numerals.

~ **(tilde)** Used on the BBC Micro at the start of a print field indicating that the item is to be printed in hexadecimal.

£ **(pound)** Not usually available, but when it occurs it often replaces the $ and is used in the same way.

↓ **(down arrow)** Represents a line feed.

→ **(right arrow)** Moves cursor right.

← **(left arrow)** Moves cursor left. Also known as "Back arrow".

< shift > ←

Deletes the current line on some machines.

π **(pi)** A function which returns the value of PI.

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ZX81 TASWORD

Tasword for the ZX81 (16K) is still available at £6·50. No demonstration cassette available but send 50p (refundable against your subsequent purchase of ZX81 Tasword) for a copy of the manual.

TOWER OF BABEL

Computers do not share a common tongue, because some languages must be task-specific. John Dawson traces their development.

HAVING TRACED some of the history of software from the first faltering machine-code steps in Manchester and Cambridge through the development of Fortran and Forth, this month we look at how information may be regarded as an asset to be examined and manipulated in many ways, rather than as data simply to be fed through a program in order to achieve a pre-ordained printout.

Language tree

First, look at figure 1 and you will see the rough historical order in which high-level languages arose and how the "original" high-level languages have bred their offspring. There are hundreds of computer languages and figure 1 shows only a very few of the more common. Fortran was written for solving scientific problems while Cobol — Common Business-Oriented Language — was commissioned by the Department of Defense in the United States for general "commercial" use. Between them, these two languages are probably used in the great majority of the world's professional computing applications.

How can that be so? There are more sophisticated languages available that are easier for the programmer to use and software development has moved on considerably from the late 1950s when they were first made available commercially. Many professional computing personnel still use Cobol as the language of choice on new hardware. Why? The answer is simple — Cobol and Fortran work, they are well-understood and that makes the task of developing a program or a suite of programs far easier than it would be if an untried language was introduced. Additionally, there are large numbers of subroutines and larger segments of programs that can be incorporated into a new piece of software.

The person who taught me anaesthetics said that "a crisis is no time to use a new technique that is unfamiliar. Stick to something ordinary that you understand well". Most software development turns into a crisis at some stage.

At the same time there is no doubt that Fortran is a pretty revolting language to use. "Structured" programming is nearly impossible using Fortran and one of the major advances in the development of programming languages has been the gradual acceptance of the idea that structure makes programs easier to read, hence less prone to error, and, most important, allowing the programmer a less constrained expression of the steps to the solution of the problem. A program built out of a number of modules will be comparatively easy to debug and can be produced by a team of programmers working to some common standards.

Easy debugging

Modules can be built very easily so that there is a single entry point and a single exit. Once again debugging becomes far easier. Forth allows program development by writing and testing the action of discrete words — modularity carried to a useful and logical conclusion. The Goto instruction, a natural development of the first machine-code programs which would go to one instruction or another depending on the result of a test, permits crossed lines of flow in a program, several entry points into a block of code and many exits. The Goto or Jump instruction is intuitively attractive and potentially highly confusing.

Many modern languages have no Goto instructions relying instead on loops controlled by Do — Until or Repeat — While operations to create structure in the program.

Computer languages can be classified in a number of ways. There are fine differences between some versions of a language and, like human speech, there are the identifiable characteristics that allow some languages to be grouped into families. After the loose "commercial" versus "scientific" distinction

epitomised by Fortran and Cobol, there is a split between interactive and batch-processing languages. An interactive computer language provides facilities that allow the programmer to make changes in the program almost as it is executing. The ordinary interpreted Basic supplied with almost every microcomputer is an interactive language. A batch-processing language makes no provision for the operator to modify the program at the computer.

I remember going to a hut behind University College in the late 1960s, sitting at a large card punch to produce a set of cards holding a Fortran program and then handing the cards across a counter in the computer department. The cards also made splendidly original party invitations with a small line of type at the top and coded holes all over the rest of the card. However, it was 24 hours later before I was able to return to collect the results of my program execution.

Fortran has now been implemented, that is installed and made to work on a number of microcomputers and has become more interactive. It is still a compiled language, which means that you must first write the source code, then compile that to object code — machine-code instructions that will execute on your machine — and finally you can run the object code to carry out the operations you wish. If an error occurs you must load the source code back into your computer, find and correct the error and start the process all over again.

Functional languages

Lisp and Prolog are examples of a group of computer languages which are known as functional languages. The other languages shown in figure 1 are "imperative" languages. A program written in an imperative language is composed of a series of statements which are obeyed by the computer. Certainly the machine may choose one of two or more conditional branches from time to time but the program is carefully prepared to take account of those possibilities. In other words, the programmer must describe quite precisely how a result is to be computed, rather than concentrating on the result itself. Functional languages work fundamentally by evluating a function and the general form of a program is:

Results = Function (input values)

For example, a question in Prolog is a program. At a very simple level a Prolog programmer might write:

```
Which (x x sex Male and x illness Glandular
Fever)
```

which might produce this on the screen of the computer:

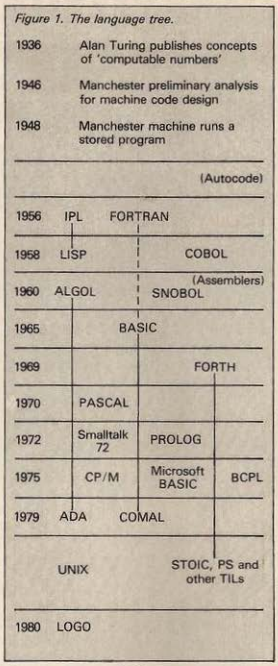
```
Answer is (Bertram Leadston)
Answer is (John Salmon)
Answer is (Nigel Mudthorpe)
No (more) answers
```

if the information had been entered, probably among a lot of other data, under the headings of "name", "sex" and "illness". In relation to the general form of the program. 'Which' is the function to be carried out and the items in the brackets are the input values.

Snobol is an example of a Markov language: that is a language in which the basic operation is to look for a pattern, substitute something in its place and choose the next statement to be carried out on the basis of the match between the two patterns. A Markov statement is said to be a random process in which the probability of a transition to a new state depends only on the current state. D W Barron says in *An Introduction to the Study of Programming Languages* that it is arguable that all algorithms — the sequence of operations necessary to solve a problem — can be reduced ultimately to Markov statements. Snobol 4 is a versatile string-processing language which can be used for text manipulation. You could, for example, look for a match in Snobol by typing the following statements:

```
STRING "John Dawson" :
S (PRINTOUT) F
(TRYAGAIN)
```

Figure 1. The language tree.



Data protection

If the words "John Dawson" appear in the characters which make up String — a Successful match — the program will branch to the label Printout. If the match Fails — F — then control will pass to the section of the program labelled Tryagain. There are many other sophisticated search and manipulation instructions in this language and Snobol may be one of the computer languages which could be used in computer applications that particularly worried the Lindop Committee on Data Protection because of the possibility of free text retrieval from very large computer files held about individuals.

The fourth loose distinction between types of computer languages differentiates between ordinary programs such as Basic and Pascal, and real-time computer languages for controlling a process as it occurs.

The hallmark of a real-time language is its ability to respond to external interruptions as peripheral devices generate information that must be taken into consideration by the program.

Because "bit-twiddling" and interrupt handling are difficult to achieve at a high level, most real-time languages tend to work in an intimate relationship with the machine's operating system. Forth, Stoic and the other Threaded Interpretative Languages are able to drop directly into low-level, and hence fast and finely controllable, assembly language which indicates that it should be simpler to try to create a real-time program in Forth than in Basic, Pascal or Fortran.

An aircraft simulator is a good example of an application that may require real-time computing, taking in the responses made by the pilot through the cockpit controls, processing that information, and then changing the attitude, speed and other simulator outputs to match the real aircraft's characteristics.

Sieve race

After all the esoteric discussion about which language suits which purpose best there are some simple stark facts based on the results of a January 1983 survey in which the same program was run on a large number of different machines using different languages on different machines.

The program was a standard version of the Sieve of Erastothenes which finds all the prime numbers between 3 and 16,381. The world's fastest computer, the Cray 1, vied with an IBM 3033 for the shortest time using Fortran — 0.110 seconds — and IBM assembly language — 0.0078 seconds — respectively.

Various microcomputers competed for the slowest time which was finally achieved by a Xerox 820 operating under CP/M and programmed in RMCobol. This combination took 5740 seconds to complete the same task — a difference of approximately 700,000 times in the speed of execution. Remember that the performance of a machine on a single program may say very little about the utility of the machine and language combination for your particular purposes.

However, that said, the fascinating statistic that I found in the listing of performance figures was for the Apple II computer programmed in Fortran. One version of Fortran running on the original 6502 central processor unit took 333 seconds to find all the expected prime numbers.

A second version of Fortran which operated under CP/M using a plug-in Microsoft card took only 34 seconds, about one tenth of the time. That difference cannot be explained by variation in the clock rates allowing one processor to run faster than another, nor can the physical construction of the machine play any significant part. The only possible explanation is that the version of Fortran running under CP/M is vastly more efficient than the other for this purpose — a better implementation of the language. ■

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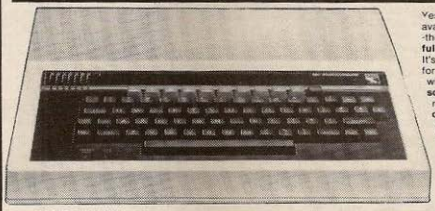

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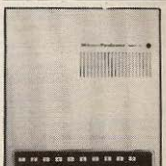

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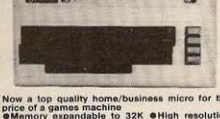

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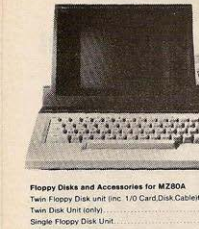
Spectrum Computer Centres have no connection whatsoever with the ZX-Spectrum Computer manufactured by Sinclair Research Ltd.

SHARP MZ-80A



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SPECTRUM FACTS

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Text Screen.....25x40
High Resolution.....Not available
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Dormans, 7-11 Broad Walk. 0582 65515

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Not all stores carry every advertised item, please phone before making a journey – Prices correct at time of going to press E. & O.E.

RESPONSE FRAME

Do you have a problem? Your manual is incomprehensible or you just cannot get the hang of that programming trick you tried — whatever it is, Tim Hartnell will do his best to answer your queries. Please include only one question per letter and mark them "Response Frame".

ACE MEMORY

■I have recently bought a Jupiter Ace. I find the 3K on board rather restrictive. What is the easiest way to expand the memory, and what size can I go up to?

Donald Towlinson,
Yate,
Bristol.

A 16K RAMPACK for the Ace is available from Stonechip Electronics, Unit 9, The Brook Industrial Estate, Deadbrook Lane, Aldershot, Hampshire. The company told me that although it is supplied as a 16K unit, it can be expanded — using chips available from them — to 32K. The extra 16K costs £19.95. You can get more details by calling the company on 0252-318260. If you want to discuss your computer with other Ace owners, you might like to get in touch with the users' club. Send a stamped, addressed envelope to Remsoft, 18 George Street, Brighton, BN2 1RH.

BOARD GAMES

■My particular computer interest is in playing board games but I would like to enlarge the normal miniscule playing board from eight by eight to 24 by 24. I gather that this can easily be done on the ZX-81 by Poking into the variable which controls the bottom half of the screen. If, however, I Poke 23659 with zero on the Spectrum I get a blank screen, remedied by altering the Border colour, but the computer then locks up. Is there a solution?

D G Daverson,
Brentwood.

THERE ARE two ways around this. Either use Print hash, or change your board size to 16 by 16. This allows you to have each square on the board occupying four character cells, and some pretty elaborate pieces can be created with user-defined graphics to fit within the 16 by 16 matrix.

MISSILE GAP

■I own an Atari 400 computer. Knowing that you have one, I decided to enquire about some things which I do not understand. I have been told that there are player-missile graphics but none of the numerous books and papers which I got with the computer signified what player-missile graphics are, or how they can be operated. Can you enlighten me? I would also like to know how one can use the user-definable graphics characters.

Thomas Martin,
Kerridge,
Macclesfield.

PAUL BUNN, in his book *Making the Most of Your Atari,* explains that there are four players and four missiles on the computer, each with its own colour register, size register and horizontal position register. A player is exactly eight bits wide by either 128 — double — or 256 — single-line resolution. To create your player, you plot the squares on a grid which is eight by whatever height you want the player to be. You then put the numbers 128, 64, 32, 16, 8, 4, 2 and 1 above the grid, adding the value if the square for the shape is filled in.

ORIC NOTICE

■I am thinking of buying an Oric computer. I will be using it, among other things, as a kind of electronic bulletin board for a club I belong to. I have seen that you can get tall letters on the BBC Micro. Is it possible to do the same with the Oric? I cannot afford a BBC machine, and have heard that the Oric would be a good second choice.

Patrick Shepson,
Leighton Buzzard.

THE ORIC has a number of commands — including the colour ones, of course — to enable you to dress up your text output. You can get double-height characters by using Control D. If you want double-height characters, you enter as part of the program

```
PRINT CHR$(4);CHR$(27);"J
....followed by text".
```

The J will not be printed. Change the J to an N to get double-height, flashing characters.

WORD PROCESS

■I am a newcomer to microcomputers and with *Your Computer* and a subscription to some books, have been trying to learn more about the mountain of hardware and software available. I want to be able to do word processing but it seems that as printers go from 80 characters upwards, to have a microcomputer displaying 32 characters is not the best way of doing it. To have to scroll a 32-character screen left to right does not seem ideal. As I am an accountant, I want to be able to compile financial software. But I feel that disc drives will make some computers I am considering, such as the NewBrain, too expensive. The Spectrum for the price seems excellent, especially with the Microdrive. Could you give me an assessment of the home-study Basic course offered by the NCC. Is it of any use to a beginner?

B J Owen,
Riyadh,
Saudi Arabia.

A BBC MICRO with word processor ROM would solve your word processing problems, but you would have to check that a suitable accountancy package is available; and also whether you can afford to add discs to the BBC machine when you get it. The NCC course has sold extremely well. While not the breeziest presentation of the subject matter available, it covers the field very competently and carefully. It is one of the best overall introductions to Basic available at the moment.

INCOMPATIBILITY

■I am still waiting for my Spectrum to be delivered. I do not know much about the machine code. I would like to know if I can use the ZX-81 machine-code articles featured in the past in *Your Computer,* and if not, what modifications would be needed to get them to work.

Farid Ehsan,
Portswood,
Southampton.

UNFORTUNATELY, the short answer is "No". Most machine-code programs put material on to the screen, and the routines to do this need to be totally rewritten for the Spectrum.

DRAGON DAZE

■I have seen a great deal of software advertised for the Dragon 32. I have only had my Dragon for a month, and am quite bewildered as to which is the best software to buy. I am mainly interested in arcade games. Can you advise me?

Gwyn Parkly,
Paisley,
Renfrewshire.

THE SCOTTISH Dragon Club, 1 Walker Street, Edinburgh may well be able to help you with information on commercial software. Suppliers of Dragon software include APG. Software, 24 Mountain View, Peel, Isle of Man; Stanley Software, 91 Cradley, Widnes, Cheshire; Saint George Software, 73 Ling Street, Liverpool, L7; DACC, 23 Waverley Road, Hindley, Greater Manchester, WN2 3BN; Juniper Computing, 8 Pembroke Green, Lea, Malmesbury, Wiltshire SN16 9PB; and Wizard Software, PO Box 23, Dunfermline, Fife, KY11 5RW. There are also a number of Dragon books around including *Dragon Load and Go, Making the Most of Your Dragon 32, Enter the Dragon* and *Dynamic Games for the Dragon 32.* See also last month's review of Dragon software in *Your Computer.*

DRAGON LORE

■I have recently bought a Dragon 32 computer and would like to know if you could recommend a book on programming in extended Basic. Also, could you tell me which other computer software is compatible with the Dragon?

Mrs J Begg,
Abergavenny,
Gwent.

THERE ARE two books on programming in Tandy Color Computer Basic available from Tandy dealers. Although these books deal with the Tandy Color Computer, they apply to the Dragon as the two computers appear to have virtually identical ROMs. Because of this, Tandy Color Computer programs will run on the Dragon 32, if you manage to buy the software on cassette. As well as the books sold by Tandy, there are several other books on programming the Tandy Color Computer available in the U.K. which should prove of use. You will probably find them advertised in this issue of *Your Computer.*

ROM SWEET ROM

■Reading the BBC Microcomputer literature, I see that "up to four different 16K interpreters" may be fitted inside the machine, and that the Basic interpreter supplied is classed as one of these. Are the other language ROMs — Pascal, Forth and Lisp — available yet? Is the mnemonic assembler part of the Basic ROM or is it part of the 16K machine's operating system, and therefore able to be accessed by the other language ROMs. Will it be possible to buy the Micro fitted with one of the other languages as standard instead of the Basic interpreter being supplied?

M E Needham
Clitheroe,
Lancashire.

THE OTHER language ROMs are being developed in order, with the Pascal one first. The assembler is part of the Basic ROM, and therefore cannot be accessed by the other language ROMs. However, it is possible that the other ROMs may include assemblers. Acorn tells me it has no plans to release the computer with any onboard language, as the initial choice, except Basic. ■

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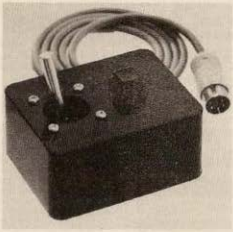
'Textstar', which stores six pages of A4 per loading, now in stock (£12.95).

Send for current listings.



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'Dragon's Teeth', which is published in the last week of every month, includes hardware and software offers, Club members adverts and local Dragon user-group news. Badges, T-shirts, Dragon sweaters and similar for extrovert owners!

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'ALSO SEE ADVERT ON PAGE 187'

SOFTWARE FILE

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Millipede

Shingo Sugiura,
Putney,
London.

BBC

YOU MUST guide a hungry baby millipede gobbling up red fruits whilst avoiding the deadly rocks. Naturally, if you guide him backwards he will bite himself and die. Every time he eats a fruit he grows by one segment. When it reaches a length of 40 segments, you will have to guide another faster baby millipede on a new screen.

You have 3 lives at your disposal. The score is constantly updated and because all the calculations and the printing of the millipede's segments are done in machine code, the action is very fast. If you want to change your speed press Escape, this will revert you back to the instructions without clearing the high score. Use Z & X for left and right respectively, and the colon and oblique stroke for up and down.

Lines 50 to 240	machine code
Lines 250 to 330	sets up screen
Lines 340 to 500	main program
Lines 520 to 700	initialise variables
Lines 710 to 900	instructions
Lines 910 to 1030	sets up screen
Lines 1040 to 1090	prints the rocks
Lines 1110 to 1200	prints the fruits
Lines 1210 to 1240	prints score and high score
Lines 1250 to 1280	new screen procedure
Lines 1290 to 1310	checks the colour in front of head
Lines 1320 to 1360	death procedure
Lines 1370 to 1390	ending procedure
Lines 1400 to 1420	delay procedure

```
  2 REM ****** MILLEPEDE ******
  3 REM ** (c) March 1983 **
  4 REM ** By Shingo Sugiura **
  5 REM **********************
  6
 10 ON ERROR GOTO 30
 20 hi%=50
 30 MODE7:PROCinst
 40 HIMEM=&2800:OSWRCH=&FFEE:LGTH%=&70:HEAD%=&71
 50 FOR I%=0 TO 2 STEP 2:P%=&2800
 60   [OPT I%
 70   LDY #40
 80   .LOOP
 90   LDA &2C1F,Y
100   STA &2C28,Y
110   LDA &2C51,Y
120   STA &2C52,Y
130   DEY
140   BNE LOOP
150   LDY (LGTH%)
160   .RHI
170   LDA #31:JSR OSWRCH
180   LDA &2C28,Y:JSR OSWRCH:LDA &2C52,Y:JSR OSWRCH
190   LDA #225 JSR OSWRCH
200   DEY
210   BNE RHI
220   LDA #31:JSR OSWRCH:LDA &2C28:JSR OSWRCH:LDA &2C52:JSR OSWRCH
230   LDA HEAD%:JSR OSWRCH
240   RTS:]NEXT I%
241
250 score%=0:life%=3:screen%=1
260 HIMEM=&2800
270 VDU22:1,23;10,32;0;0;0;19,3,2;0;17,1,17,131,12
280 HIMEM=&2800
290 PROCdata
300 PROCinit
310 PROCwall
320 PROCobst
330 PROCFood
340 REPEAT
350 IF INKEY(-98)=-1 THEN A$="LEFT"
360 IF INKEY(-67)=-1 THEN A$="RIGHT"
370 IF INKEY(-73)=-1 THEN A$="UP"
380 IF INKEY(-105)=-1 THEN A$="DOWN"
390 PRINTTAB(?&2C28+?LGTH%,?&2C52+?LGTH%);" "
400 IF A$="LEFT" THEN ?&2C28=(?&2C28)-1:?HEAD%=229
410 IF A$="RIGHT" THEN ?&2C28=(?&2C28)+1:?HEAD%=228
420 IF A$="UP" THEN ?&2C52=(?&2C52)-1:?HEAD%=226
430 IF A$="DOWN" THEN ?&2C52=(?&2C52)+1:?HEAD%=227
440 VDU26:col%=POINT(?&2C28+32+16,(31-?&2C52)*32+16)
450 IF col%<>3 THEN PROCcheck
460 PROCnumerics
470 CALL &2800
480 PROCwait(speed%)
490 UNTIL ?LGTH%>=40:PROCnew_screen
500 GOTO270
510                    ********************************
520 DEFPROCinit
530 ENVELOPE1,1,3,2,-2,6,6,6,100,0,0,-5,100,0
540 VDU23,224,255,255,255,255,255,255,255,255
550 VDU23,225,24,36,126,189,189,126,36,24
560 VDU23,226,66,36,24,126,219,126,60,24
570 VDU23,227,24,60,126,219,126,24,36,66
580 VDU23,228,16,57,186,252,252,186,57,16
590 VDU23,229,8,156,86,63,63,86,156,8
600 VDU23,230,0,24,40,92,126,190,127,120
610 col%=3
620 A$="RIGHT":?LGTH%=2
630 Screen1
640 ENDPROC
650 DEFPROCdata
660 FOR Xdata=0 TO 40
670   ?&2C28+Xdata)=Xdata+15:NEXT Xdata
680 FOR Ydata=0 TO 40
690   ?&2C52+Ydata)=15:NEXT Ydata
700 ENDPROC
701
710 DEFPROCinst
720 PRINTTAB(13,1)CHR$(130)CHR$(141)"MILLEPEDE"
730 PRINTTAB(13,2)CHR$(130)CHR$(141)"MILLEPEDE"
740 PRINT:CHR$(131)TAB(11)"BY SHINGO SUGIURA"
750 PRINT:CHR$(132);"You must guide the growing millipede"
760 PRINT:CHR$(132);"towards the ripe fruits while avoiding"
770 PRINT:CHR$(132);"the rocks ."
780 PRINT:CHR$(132);"If you try to guide him backwards he"
790 PRINT:CHR$(132);"will bite his self and die."
800 PRINT:CHR$(132);"  You have 3 lives."
810 PRINT" To change level press ESCAPE .."
820 PRINT:CHR$(132);"CONTROLS :-"
830 PRINT:CHR$(134);"UP  ---------- ';'"
840 PRINT:CHR$(134);"DOWN ---------- '/'"
850 PRINT:CHR$(134);"LEFT ---------- 'Z'"
860 PRINT:CHR$(134);"RIGHT ---------- 'X'"
870 PRINT" Input speed (0 fast to 9 slow) ";:REPEATI%=INSTR("0123456789",GET$
)UNTILI%:PRINT;I%-1:speed%=(I%-1)*10
880 PRINT:CHR$(136);CHR$(130);TAB(7);"Press SPACE BAR to start";
890 REPEAT UNTIL GET=32
900 ENDPROC
901
910 DEFPROCwall:COLOUR0
920 VDU31,13,0,226:PRINT" MILLEPEDE ";CHR$226
930 PRINT TAB(2,2);STRING$(36,CHR$224)
940 PRINT TAB(2,20);STRING$(36,CHR$224)
950 FOR WALL=2 TO 27
960   PRINTTAB(2,WALL)CHR$224
970   PRINTTAB(37,WALL)CHR$224
980   SOUND &11,-10,WALL*2+100,2
990   PROCwait(50)
1000  NEXT WALL
1010 PRINT TAB(3,30);"Score ";score%;TAB(20,30);"High score ";hi%;
1020 PRINT TAB(3,31);"Lives left ";life%;TAB(20,31);"Screen ";screen%;
1030 ENDPROC
1031
1040 DEFPROCobst
1050 FOR OBST=1 TO screen%*3+10
1060   PRINTTAB(RND(33)+3,RND(24)+2)CHR$230
1070   SOUND0,-15,6,1
1080   PROCwait(100)
1090   NEXT OBST:ENDPROC
1100
1110 DEFPROCFood:COLOUR1
1120 FOR FOOD=1 TO 50
1130   PROCwait(100)
1140   SOUND1,-10,RND(200),1
1150   PRINTTAB(RND(33)+3,RND(24)+2);"*"
1160   NEXT FOOD
1170 VDU17,01,17,15,228,17,1
1180 PRINT TAB(18,15);" Ready !":PROCwait(2000)
1190 PRINT TAB(18,15);"       "
1200 ENDPROC
1201
1210 DEFPROCnumerics:COLOUR0
1220 IF score%>=hi% THEN hi%=score%
1230 PRINT TAB(9,30);score%;TAB(31,30);hi%
1240 ENDPROC
1241
1250 DEFPROCnew_screen
1260 PROCwait(2000)
1270 screen%=screen%+1:speed=speed-10:IF speed<0 THEN speed=0:CLG
1280 ENDPROC
1281
1290 DEFPROCcheck
1300 IF col%=1 THEN score%=score%+1:?LGTH%=(?LGTH%)+1:SOUND1,1,1,3:ENDPROC
1310 IF col%=0 THEN PROCdead:ENDPROC
1311
1320 DEFPROCdead
1330 SOUND0,1,50,5
1340 PROCwait(1500)
1350 life%=life%-1:IF life%<0 THEN PROCend
1360 CLG:GOTO270:ENDPROC
1361
1370 DEFPROCend
1380 PRINT"DEAD":PRINT"Press SPACE BAR to replay ":REPEAT UNTIL GET=32
1390 GOTO258:ENDPROC
1391
1400 DEFPROCwait(Tk)
1410 FOR Delax%=0 TO Tk:NEXT Delax%
1420 ENDPROC
```

Surrounded

Mark Easton,
Mapperley,
Nottingham.

ZX-81

SURROUND IS a novel addictive game for the ZX-81, requiring a good strategic mind. The program takes up just under 4K of memory. The instruction and a sample of the graphics are shown with the listing. In order to make the program easier to understand, Rem statements are included. The program gives a good example of how to Peek and Poke into the display file. Another interesting point is line 2020. This one line replaces:

```
IF R=4 THEN LET CP=CP+1
IF R=3 THEN LET CP=CP-1
IF R=2 THEN LET CP=CP+33
IF R=1 THEN LET CP=CP-33
```

```
  1 REM [illegible]
  2 REM [illegible]
  3 LET HG=0
  5 GOSUB 9100
 10 LET PO=110
 20 GOSUB 1000
 30 LET Z=0
 40 LET U=0
100 LET I$=INKEY$
105 IF I$="" THEN GOTO 100
110 LET L=PO
115 IF (CODE I$)>36 OR (CODE I$
)<33 THEN GOTO 100
120 LET PO=PO+(I$="8")-(I$="5")
+33*((I$="6")-(I$="7"))
125 LET G=G+1
127 LET PP=PEEK 16396+256*PEEK
16397+PO+1
```

(continued on next page)

(continued from previous page)

```
130 IF PEEK PP=128 THEN GOTO 90
0
135 IF PEEK PP=52 THEN GOTO 900
0
137 IF PEEK PP=10 THEN GOTO 800
0
140 POKE PP,23
145 POKE PEEK 16396+256*PEEK 1
6397+L+1),0
150 GOSUB 2000
155 PRINT AT 21,29;G
160 GOTO 100
1000 REM **DRAW PLAYING AREA**
1001 FOR R=1 TO 5
1002 PRINT AT RND*6,RND*30;"O"
1004 NEXT R
1005 PRINT AT 0,0;
1007 PRINT "
1010 FOR R=1 TO 6
1020 PRINT "■";TAB 31;"■"
1030 NEXT R
1035 FOR R=1 TO 12
1040 PRINT "
1042 NEXT R
1043 PRINT AT 19,0;"
1044 PRINT "
1045 PRINT AT 3,11;"■"
1047 PRINT AT 21,2;NG
1050 RETURN
1999 REM **PLACE BLOB**
2000 LET CP=PO
2010 LET R=INT (RND*4)+1
2020 LET CP=CP+(R=4)-(R=3)+33*((
R=2)-(R=1))
2025 LET PZ=PEEK 16396+256*PEEK
16397+CP+1
2030 IF PEEK PZ=128 THEN GOTO 20
00
2035 IF PEEK PZ=52 THEN GOTO 210
0
2040 POKE PZ,128
2050 RETURN
2099 REM **EXPAND FRAME**
2100 LET Z=Z+1
2102 IF Z>18 THEN LET Z=18
2105 POKE PZ,0
2107 POKE PP,32
2110 PRINT AT Z,1;"
2115 PRINT TAB 1;"
2120 PRINT AT Z,(RND*28)+1;"O";A
T Z+1,(RND*28)+1;"O"
2130 RETURN
2999 REM **YOU WIN**
3000 PRINT AT 0,0;"WELL DONE"
3002 POKE (PEEK 16396+256*PEEK 1
6397+L+1),0
3004 POKE PP,151
3010 GOTO 9030
3999 REM **YOU ARE DESTROYED**
3000 POKE (PEEK 16396+256*PEEK 1
6397+L+1),0
3010 POKE PP,8
3020 PRINT AT 0,10;"YOU'VE DIED"
3030 IF G<HG THEN GOTO 3040
3040 PRINT AT 1,3;"YOU HAVE THE
HIGH SCORE"
3045 LET HG=G
3046 PRINT AT 21,2;G
3050 PRINT AT 20,9;"HIT ANY KEY"
3055 PRINT AT 21,29;"
3065 IF INKEY$<>"" THEN GOTO 906
0
3070 IF INKEY$="" THEN GOTO 3070
3075 CLS
3080 GOTO 10
```

```
9100 REM **INSTRUCTIONS**
9110 PRINT TAB 11;"SUROUND"
9120 PRINT "
9130 PRINT "  THE GAME TAKES PL
ACE IN A "BLACK FRAME CONTAININ
G ABOUT 65 "DEATH PITS "O" WH
CH YOU MUST "AVOID. YOU PEICE I
S "*"
9140 PRINT "  HOUEVER, AFTER YO
UR TURN,THE "COMPUTER WILL PLAC
E A BLOB "■" IN A VACANT SQU
ARE IN AN ATTEMPTTO SURROUND YOU.
  IF YOU HIT A "BLOB THEN YOU AR
E EVAPORATED."
9150 PRINT "  BUT IF YOU MANAGE
 TO MAKE THE "BLOB LAND ON A PIT
YOU WILL SEE,"THAT THE FRAME EX
PANDS. THIS WAY YOU SURROUND THE
ATRAIN DEATH IS "TO REACH THE GR
AY LINE. WHEN "CAN ONLY BE REA
CHED BY FULLY "EXPANDING THE FR
AME, BUT DON"T EXPAND IT PAS
T THE GRAY LINE."
9160 PRINT AT 21,0;"(HIT ANY KEY
 TO CONTINUE)"
9170 IF INKEY$<>"" THEN GOTO 9170
9180 CLS
9190 GOSUB 1000
9200 PRINT AT 0,1;"
9210 PRINT AT 21,0;"HIT ANY KEY
9220 IF INKEY$<>"" THEN GOTO 922
0
9230 IF INKEY$="" THEN GOTO 9230
9240 CLS
9250 RETURN
9998 SAVE "SUROUND"
9999 RUN
```

Block blitz

Robert Newton,
Wadhurst,
Sussex.

SPECTRUM

THIS COMBINES attractive graphics with very interesting sound effects. It is based upon the Vic-20 game of Blitz and helpfully tells you how many people you massacred if your aircraft runs into too many tower blocks. A high-score routine and variable number of chances have been included to add the competitive nature of the game. If the subroutine at line 7000 is included, then it will start up with some attractive large characters using the machine-code routine of the Horizon cassette which every Spectrum owner will have. Just run one of the programs on the Horizons cassette and then break the program and type in as a direct command:

SAVE "mc" CODE 32256, 300

to be saved, after the Blitz program on cassette.

```
  10 REM      blitz
  11 RESTORE : LET hc=1000: LET
k=0: BORDER 4: PAPER 0: INK 7: C
LS
  50 REM ** LOAD PLAYER **
  100 DATA 255,128,255,255,255,255
,128,255
  110 FOR n=0 TO 7
  120 READ a
  130 POKE USR "a"+n,a
  140 NEXT n
  150 RESTORE : FOR n=0 TO 7
  160 DATA 24,24,102,102,219,219,
219,255
  240 FOR n=0 TO 7
  250 READ a: POKE USR "b"+n,a
  260 NEXT n
  270 REM "c"
  280 DATA 219,219,219,255,219,21
9,219,219
  290 FOR n=0 TO 7
  300 READ a
  310 POKE USR "c"+n,a
  400 REM "d"
  410 DATA 231,231,231,255,255,23
1,231,231
  490 FOR n=0 TO 7
  500 READ a
  510 POKE USR "d"+n,a
  520 NEXT n
  530 REM "e"
  540 DATA 24,24,24,24,60,126,231
,231
  550 FOR n=0 TO 7
  560 READ a: POKE USR "e"+n,a: NEXT n
  570 REM "f"
  580 DATA 24,60,126,219,153,153,
255,255
  590 FOR n=0 TO 7
  600 READ a: POKE USR "f"+n,a
  610 NEXT n
  700 REM "g"
  710 DATA 255,153,255,153,255,15
3,255,255
  800 FOR n=0 TO 7
  810 READ a: POKE USR "g"+n,a
  820 NEXT n
  900 REM "h"
  910 DATA 255,146,73,146,73,146,
73,146
  920 DATA 146
  930 DATA 73
  940 DATA 146
  950 DATA 73
  960 DATA 146
  970 DATA 73
  980 DATA 255
  990 FOR n=0 TO 7
  1000 READ a: POKE USR "h"+n,a
  1010 NEXT n
  1020 REM "H"
  1030 CLS : BRIGHT 0
  1040 PRINT AT 21,0;"HHHHHHHHHHHH
HHHHHHHHHHHHHHHH"
  1050 FOR y=20 TO 14 STEP -1
  1060 PRINT AT y,2;"cc";AT y,5;"b
";AT y,7;"a";AT y,9;"dd";AT y,13
;"cc";AT y,15;"bbb";AT y,19;"c";
AT y,22;"ccc";AT y,24;"d";AT y,2
9;"ddd"
  1080 NEXT y
  1100 PRINT AT 13,2;"cf";AT 13,5;
"b";AT 13,7;"g";AT 13,9;"ee";AT
13,12;"ec";AT 13,15;"fbe";AT 13,
19;"bcge";AT 13,24;"f";AT 13,26;
"cedge"
  1110 PRINT AT 12,2;"c";AT 12,5;"
f";AT 12,7;"c";AT 12,10;"e";AT 1
2,13;"c";AT 12,15;"b";AT 12,20;"
cgf";AT 12,25;"c";AT 12,28;"bf"
  1130 PRINT AT 11,2;"f";AT 11,5;"
g";AT 11,10;"b";AT 11,13;"d";AT
11,20;"b";AT 11,23;"c";AT 11,26;
"bf";AT 11,28;"b";AT 10,7;"
";AT 10,9;"c";AT 10,26;"
";AT 10,28;"c"
  1140 INPUT "Ar 9/7;"e";AT 9,13;"c
"
  1160 PRINT AT 8,7;"f";AT 8,13;"b
"
  1161 INK 7: BRIGHT 0
  1165 DATA 0,112,248,248,255,255,
0,0
  1166 RESTORE 1165: FOR n=0 TO 7
  1168 READ a: POKE USR "i"+n,a
  1169 NEXT n
  1170 DATA 7,1,50,116,255,255,255
,255
  1180 FOR n=0 TO 7
  1190 READ a: POKE USR "j"+n,a
  1200 NEXT n
  1300 DATA 248
  1310 DATA 248
  1400 DATA 64
  1410 DATA 248
  1420 DATA 248
  1430 DATA 240
  1440 DATA 240
  1450 DATA 240
  1460 FOR n=0 TO 7
  1470 READ a: POKE USR "k"+n,a
  1480 NEXT n
  1490 LET p=0: LET k=0
  1500 LET bx=0: LET bx=0
  1510 REM ** start game
  1520 INPUT "How many chances ?";
c
  1530 IF rx>0 THEN PRINT AT ry,rx
;"j"
  1540 PRINT AT ry,rx;"jk"
  1541 IF ATTR (ry,rx+3)=2 THEN LE
T k=k+1
  1542 BEEP .001,10: BEEP .002,30:
PRINT AT ry,rx;"
  1543 IF k>=c THEN GO TO 4000
  1544 IF k=c-1 THEN LET ry=ry+1
  1570 IF ry>=21 AND rx>=29 THEN G
O TO 4000
  1575 IF rx>=29 THEN PRINT AT ry-
1;"
  1580 IF rx>=29 THEN LET rx=0
  1585 LET rx=rx+1
  1590 LET a$=INKEY$
  1600 IF INKEY$="" THEN GO TO 152
0
  1610 REM do top bs
  1611 BEEP .001,0: BEEP .002,8: E
BEP .001,4: BEEP .002,5: BEEP .0
02,10: BEEP .002,12: BEEP .002,2
0
  1630 IF ry>=20 THEN LET by=21
  1635 IF bx=rx THEN LET bx=rx+1
  1640 IF bx>=29 THEN LET bx=29
  1645 IF bx<=0 THEN LET bx=1
  1646 IF by=21 THEN PRINT AT 21,b
x;"bb"
  1647 IF by=21 THEN GO TO 8000
  1650 IF by>=1 THEN PRINT AT by-1,
bx;"bb": PRINT AT by,bx;"a"
  1651 BEEP .001,60-by
  1660 LET by=by+1
  1670 IF ry>=21 AND rx>=29 THEN GO
TO 4000
  1671 PRINT AT ry,rx-1;"
  1672 PRINT AT ry,rx;"jk"
  1673 IF rx>28 THEN PRINT AT ry,2
8;"
  1704 IF ATTR (ry,rx+4)=2 THEN LE
T k=k+1
  1705 IF k>=c THEN GO TO 4000
  1706 IF rx>=29 THEN PRINT AT ry,2
9;"
  1710 IF rx>28 THEN LET ry=ry+1
  1720 IF rx>28 THEN LET rx=0
  1730 LET rx=rx+1
  1740 GO TO 1630
  2000 REM
  2001 PRINT AT 20,bx;" "
  2002 BEEP .001,0: BEEP .02,50
  2010 GO TO 1630
  3000 REM End  Survived
  3001 IF bx=hc THEN LET hc=c
  3010 PRINT AT 0,0;"A safe landin
g.  You had ";c;
  "chances and bumped ";k;
  " buildings !!!";"Press any key
to re-fly"
  3011 PRINT #"The lowest number o
f chances  needed so far is ";
hc
  3020 IF INKEY$="" THEN GO TO 302
0
  3021 RESTORE 1165
  3030 GO TO 1030
  4000 REM End  crashed
  4001 IF k=c AND rx>=29 AND rx>=E
S THEN GO TO 3000
  4010 IF rx<=28 THEN PRINT AT ry,
rx+2;"
  4020 LET xc=8*(rx+3): LET yc=8*(
21-ry)
  4030 FOR n=0 TO 40
  4040 PLOT INK INT (RND*7)+1;xc,y
c
  4041 DRAW INK INT (RND*7)+1;INT
(RND*10+1),INT (RND*10+1): PLOT
INK INT (RND*7)+1;xc,yc: DRAW IN
K INT (RND*7)+1;INT (RND*-10+1),
INT (RND*10+1)
  4042 BORDER RND*7
  4043 PLOT INK INT (RND*7+1);xc,y
c: DRAW INK INT (RND*7+1);RND*-
8,RND*-10: PLOT xc,yc: DRAW INK
INT (RND*7+1);RND*8,RND*-10
  4050 BEEP .01,RND*70-20: NEXT n
  4060 REM
  4100 PRINT AT 0,0;"Bad luck,you
hit a forest block and blew up"
  4101 PRINT AT 10,0;"people!!!"
  4102 PRINT "You had ";c;" chance
s!!!a few more next time!"
  4103 PRINT #"Press any key to h
ave another massacre !!!"
  4110 IF INKEY$="" THEN GO TO 411
0
  4111 RESTORE 1165
  4120 GO TO 1030
  5000 REM
       LARGE CHARACTER
       INTRODUCTION FOR
       "BLITZ" "BY ALLEN
       HORTON" CODE ROUTINE.
  7000 CLEAR 32255: LOAD "mc" CODE
  32256: RANDOMIZE USR 32256
  7010 GO TO 9950
  7020 LET xs=21-8*xs: LET ys=(ys+
2)*8
  7100 FOR l=1 TO 8
  7110 FOR i=1 TO ys
  7120 FOR j=1 TO xs
  7130 FOR k=1 TO xs
  7140 FOR l=1 TO xs
  7150 FOR m=1 TO 8
  7160 LET w=w+1
  7170 LET w=LEN p$
  7180 LET n=CODE p$(n)
  7190 NEXT n
  7200 FOR n=1 TO w
  7210 FOR l=w+1,255
```

(continued on page 165)

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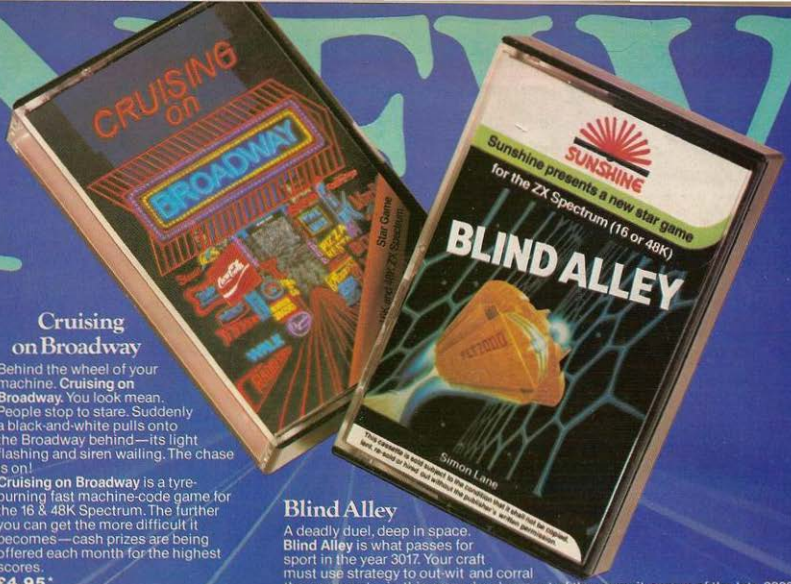

Cruising on Broadway

Behind the wheel of your machine. **Cruising on Broadway.** You look mean. People stop to stare. Suddenly a black-and-white pulls onto the Broadway behind—its light flashing and siren wailing. The chase is on!
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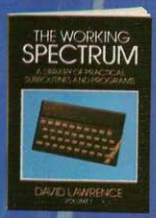

The Working Dragon 32

This is a companion volume to The Working Spectrum and includes several new features such as a Text Editor and a Music Composer and Editor. Other programs help you use the Dragon 32 as an accountant, for more advanced high resolution graphics, as a home tutor for education and for playing games. Each of the programs and subroutines is explained line by line to help develop your own programming skills.
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SOFTWARE FILE

(listing continued from page 162)

```
9320 LET w=USR 32256
9330 RETURN
9340 PAPER 7: BORDER 2: PAPER 2: FLASH 0: INVERSE 0: BRIGHT 1: IN
K 7: CLS
9350 LET r$="© Robert Newton": L
ET y=1
9370 LET x=8: LET y=3
9380 GO SUB 9390
9390 PLOT x,y: INK 0: LET r$="Pre
ss any key to continue": LET r$=
r$ AND y=3: LET y=156: GO SUB
9390
9310 PAUSE 0
9320 RUN
```

Juggler

J Charlesworth,
Kings-Lynn,
Norfolk.

SPECTRUM

THE OBJECT of this game, for the 16 or 48K ZX Spectrum, is to keep the balls which are bouncing around the screen from hitting the bottom of the screen. To do this, you move a bat back and forth across the bottom of the screen, trying to make the balls land on it so they can rebound upwards.

At first there is just one ball, but every 25 seconds another ball is added and your points, displayed in the top right-hand corner, go up in steps of however many balls there are. All the controls are printed by the computer on running the program.

For speed, I have written all the moving graphics section in machine code. This is stored in the data statements from line 9000 onwards, which the computer will check for errors with a checksum when it is run.

```
  1 BORDER 0: PAPER 0: INK 7
 10 GO TO 2000
 20 LET a$=":                    JUGGLER
                    ": LET x=10: GO SUB
200
 30 LET a$=":                    5 (-
   ->8                    ": LET x=12: GO SUB
200
 40 LET a$=": H=HOLD
   5=STRAT                    ": LET x=14: GO SUB
200: GO TO 300
200 FOR a=1 TO LEN a$: PRINT AT
x,a; BRIGHT 1;a$(LEN a$-a+1): NE
XT a: BEEP .01,x*3: NEXT a: RETURN
300 FOR a=1 TO 10: POKE 32346+4
*a,INT (RND*6)+3: POKE 32347+4*a
,INT (RND*20)+2: POKE 32349+4*a,
1-(2 AND RND>.5): POKE 32349+4*a
,1-(2 AND RND>.5): NEXT a
310 LET a$=":                    PRESS 5
                    ": LET x=21: GO SUB
200
320 GO SUB 500
330 CLS : PRINT AT 0,0;: LET t=
USR 32000
340 LET r=0: LET p=0: GO SUB 40
0
350 IF INKEY$="h" THEN GO SUB 5
00
360 IF PEEK 23673>=5 THEN GO SU
B 600
370 LET p=p+r: PRINT AT 0,27;p
APER 1;p, PAPER 0: LET l=USR 325
27: IF PEEK 23296<>99 THEN GO TO
350
380 GO TO 300
400 POKE 23672,0: POKE 23673,0:
LET r=r+(1 AND r<>10): POKE 325
21,r: POKE 23275,r: POKE 23278,3
0-4*r: PRINT AT 0,1; PAPER 1;"AO
UND ";r;AT 0,20;"POINTS ";p: RET
URN
500 LET t=PEEK 23672: LET t1=PE
EK 23673
510 IF INKEY$<>"s" THEN GO TO 5
10
520 POKE 23672,t: POKE 23673,t1
9000 DATA 62,17,215,62,1,215,62,
0,215,62,6,215,62,24,215,62,16,
0,215,62,5,215,62,33,215,62,215,
62,57,215,62,30,215,62,215,62,1,
62,16,215
9010 DATA 201
9020 DATA 62,0,50,129,92,1,254,2
39,237,91,129,92,27,124,181,176,
5,254,186,40,7,62,1,50,129,92,24
,14,60,176,92,254,201,40,7,62,28
5,50,129,92,24,1,61,50,129,92,62
9030 DATA 56,129,92,254,1,32,16,
42,170,92,35,126,254,0,40,7,43,
43,34,170,92,201,35,126,254,0,40
,7,43,43,34,170,92,201,62,1,201
9050 DATA 62,22,215,62,0,215,62,
215,124,215,62,10,215,62,7,215,1
2,124,215,62,31,215,62,1,215,124
,194,130,95,203,244,126,254,7,32
,23,43,0,91,112,35,115,62,22,215,
120
9060 DATA 215,123,215,123,16,215,
64,215,62,144,215,124,254,3,40,7,
58,2,91,134,119,35,91,205,244,12
4,254,3,32,10,58,2,91,237,66,50,
3,91,64,35,43,91,70,35,58,3,91,
112,35,205,244,124,201
9070 DATA 92,10,58,0,91,237,66,5
0,2,91,24,12,33,2,91,126,237,66
115,35,126,237,66,119,33,0,91,58
,2,91,134,119,35,58,0,91,134,119
,43,70,35,94,62,22,215,120,215,1
93,215,62,16
9080 DATA 215,62,4,215,62,144,21
5,33,0,11,17,20,0,205,161,3,201
9081 DATA 193,225,6,10,197,33,50
,0,6,0,197,229,17,4,0,205,161,3,
225,193,35,16,[illegible]15,193,16,-22,62,
0,215,91,201
9090 CLEAR 31999: LET a$=":
  PLEASE WAIT                    ": LET
x=10: GO SUB 200
9095 LET t=8: FOR a=32000 TO 323
42: READ b: LET t=t+b: POKE a,b:
NEXT a: IF t<31720 THEN GO TO
9999
9100 RESTORE 9105: LET t=0: FOR
a=32500 TO 32695: READ b: LET t=
t+b: POKE a,b: NEXT a: IF t<105
00 THEN GO TO 9999
9105 DATA 197,215,229,215,62,0,1
64,40,9,17,62,0,33,0,88,49,16,20
,209,62,0,35,126,254,0,40,7,43,4
3,110,126,254,0,40,7,43,43,102,1
17,0,91,237,160,237,160,237,160,
237,160
9120 DATA 205,142,125,225,215,17
,0,9,205,126,254,31,205,126,237,
160,237,160,237,160,237,160,235,
193,16,-39
9130 DATA 205,52,125,6,2,197,6,3
0,197,6,16,197,16,-8,205,62
,125,193,16,-21,201
9140 RESTORE 9145: FOR a=0 TO 7:
READ b: POKE USR a+a,b: NEXT a
: DATA 60,126,255,255,255,255,1
26,60
9150 GO TO 29
9999 PRINT AT 10,7; FLASH 1;"
DATA ERROR  ": STOP
```

Sound analysis

Predrag Bogdanovic,
Belgrade,
Yugoslavia.

ZX-81

THIS MACHINE-CODE program for the ZX-81 draws graphics illustrating sound. Sound is fed in on the Ear socket. To Load program create a Rem line 45 characters long. Use any hexloader to enter the code. The program is executed by RAND USR 16526. If you want the computer to draw one graphic and then return to Basic type:

POKE 16551,192(N/L)

POKE 16552,0(N/L)
POKE 16553,0(N/L)

or else the computer will clear display and draw again. The program returns to Basic when is pressed any key. The Subroutine at address 4082h — 16514 — gives — in C register — the frequency of the tone on the ear socket.

```
4082: 01 00 ff          4099: 4a
      db fe                   cb 38
      3c                      cb 38
      20 01                   d5
      0c                      cd b2 0b
      10 f8                   d1
      c9                      14
408e: 16 00                   d5
      cd 82 40                cb 72
      2a 25 40                c4 2a 0a
      2c                      d1
      c0                      cb b2
      41                      18 e1
```

Sub hunt

Jason Bumford,
Hanham,
Bristol,

VIC-20

SUB HUNT runs in an unexpanded Vic-20. It shows a minesweeper on the sea's surface, which moves left and right under machine-code control, while the rest of the Basic program controls submarines passing at random depths and directions. The minesweeper can drop depth charges from the bow and stern and the submarines will randomly retaliate with torpedos. Each sub sunk scores 10 points, and a deliberately wasted depth charge loses two points. A torpedo strike wipes our your score completely. The waste bomb key enables players to detonate depth charges in order to launch another if he has missed. User defined graphics are extensively used. When typing in the program ensure that no unnecessary spaces are left, because the whole memory is needed.

```
 1 POKE36878,15
 6 POKE55,18:POKE56,28
 10 PRINT"[illegible]AIT"[illegible]LL=0
 30 FORA=7168TO7679:POKEA,PEEK(A+25600):NEXT
 50 FORA=7432TO7503:READB
 70 POKEA,B:NEXTA
 81 GOSUB800:POKE0,197:POKE1,0:POKE673,0:POKE674,11:POKE675,33:POKE676,34:GOTO11
00
 90 DATA3,1,7,23,255,127,63,31,192,128,224,232,255,254,252,248
 110 DATA1,1,5,31,63,63,63,31,224,224,254,255,255,255,254
 130 DATA255,0,0,0,0,0,0,0,0,42,28,28,42,0,0,0,28,28,28,60,254,254,124
 137 DATA0,1,30,32,67,68,137,137,240,12,228,18,17,145,81,81
 138 DATAAC,A2,02,A9,20,99,2B,1E,A9,20,99,2C,1E,A2,00,A1,00,CD,A3,02,D0,07,C0,02
,F0,03
 139 DATA88,A1,00,CD,A4,02,D0,05,C0,14,F0,01,C8,A9,21,99,2B,1E,A9,22,99,2C,1E,8C
A2,02,60
 140 CLR:POKE36879,10:POKE36869,255:PRINT"[illegible]"
 141 PRINT"[illegible]":SYS680
 143 A$(0)="22812231215221522151219122312251228222822283m"
 145 FORA=1TO50STEP4:B=VAL(MID$(A$(0),A,3)):C=VAL(MID$(A$(0),A+3,1)):E=50:IFC=2T
HENE=100
 146 IFC=3THENE=200
 147 POKE36875,B:FORD=1TOE:NEXTD:POKE36875,0:NEXT
 150 CLR V=36875:SS=8185
 160 X=7834:L=X
 170 GOSUB500:TI$="000000"
 180 GET A$:SYS680
 181 PRINT"[illegible]TIME "MID$(TI$,4,1)","RIGHT$(TI$,2)
 182 Z0=INT(RND(8)*21):IFZ0=3THENGOTO930
 183 IFTI$="000200"THENFORH=255TO128STEP-,1:POKEV+1,H:NEXT:POKEV+1,0:GOTO1000
 184 IFRZ=-1THENIFX=L+(F*22)-23THENPOKEX+2,32:POKEX+1,32:GOSUB500
 185 IFLL=0THENIFA$=","THENLL=5:KK=0:GOSUB900:GOSUB700:POKEH,32:H=H+44
 186 IFLL=0THENIFA$="."THENLL=5:GOSUB700:KK=3:GOSUB900:GOSUB700:POKEH,32:H=H+44
 195 SYS680:IFLL<>5THEN230
 200 IFA$="/"THENLL=8:SC=SC-2:POKEH,32:FORI9=1TO30:POKEV+2,210:NEXT:POKEV+2,0
 230 POKEX,35:POKEX+1,36:POKEX-1,32:POKEX+2,32
 240 SYS680:X=X+RZ:IFX=L+(F*22)+21THEN POKEX,32:POKEX-1,32:GOSUB500 -
 245 SYS680:POKEV+1,240:POKEV+1,0
 246 IFLL=5THENHH=22:POKEH,38:IFPEEK(H-1)<>320RPEEK(H+1)<>32THENPOKEH-22,32:GOS
UB600
 247 IFLL=5THENIFH<8120THENPOKEH-22,32
```

(continued on page 167)

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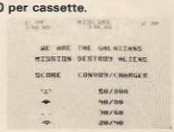

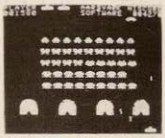

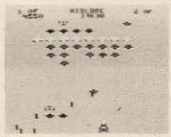

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SOFTWARE FILE

Organisation

Andrew Dixon-Symes
West Croydon,
Surrey.

ORIC

THIS PROGRAM, for any size of Oric, turns the machine into a three-voice organ. It also shows how the play commands can be used to turn the certain voices on and off. The instructions are included in the program, and stay on screen while the program is running.

The second short program for Oric, demonstrates the high-resolution graphics of the machine whilst using the pattern command to give the lines being drawn a lace effect.

```
10 REM **** Three Voice Synthesizer ****
20 REM ****    Copyright2/3/1983    ****
30 REM ****    Andrew Dixon-Symes   ****
40 GOSUB 520
50 :
60 PLAY7,0,0,0
70 K$=KEY$
80 :
90 REM   ****  VOICE ONE  ****
100 :
110 IFK$="1"THENMUSIC1,2,1,4
120 IFK$="2"THENMUSIC1,2,3,4
130 IFK$="3"THENMUSIC1,2,5,4
140 IFK$="4"THENMUSIC1,2,6,4
150 IFK$="5"THENMUSIC1,2,8,4
160 IFK$="6"THENMUSIC1,2,10,4
170 IFK$="7"THENMUSIC1,2,12,4
180 :
190 REM   ****  VOICE TWO  ****
200 :
210 IFK$="Q"THENMUSIC2,3,1,4
220 IFK$="W"THENMUSIC2,3,3,4
230 IFK$="E"THENMUSIC2,3,5,4
240 IFK$="R"THENMUSIC2,3,6,4
250 IFK$="T"THENMUSIC2,3,8,4
260 IFK$="Y"THENMUSIC2,3,10,4
270 IFK$="U"THENMUSIC2,3,12,4
280 :
290 REM   ****  VOICE THREE  ****
300 :
310 IFK$="A"THENMUSIC3,4,1,4
320 IFK$="S"THENMUSIC3,4,3,4
330 IFK$="D"THENMUSIC3,4,5,4
340 IFK$="F"THENMUSIC3,4,6,4
350 IFK$="G"THENMUSIC3,4,8,4
360 IFK$="H"THENMUSIC3,4,10,4
370 IFK$="J"THENMUSIC3,4,12,4
380 :
390 REM   ****  CONTROL PANEL  ****
400 :
410 IFK$="Z"THENPLAY0,0,0,0
420 IFK$="X"THENPLAY1,0,0,0
430 IFK$="C"THENPLAY2,0,0,0
440 IFK$="M"THENPLAY4,0,0,0
450 IFK$="B"THENPLAY5,0,0,0
460 IFK$="N"THENPLAY6,0,0,0
470 IFK$="L"THENPLAY7,0,0,0
480 IFK$=" "THENPLAY0,0,0,0:STOP
500 GOTO70
510 :
520 REM   ****  INSTRUCTIONS  ****
530 :
540 CLS
550 PLOT10,2,"THREE VOICE SYNTHESIZER"
560 PLOT10,3,"----- ----- -----------"
570 A=CHR$(96)+"Andrew Dixon-Symes1983"
580 PLOT7,4,A$
590 PLOT3,7,"*** INSTRUCTIONS ***"
600 PLOT1,9,"VOICE-1:Numbers 1-7 In Octave 2"
610 PLOT1,10,"VOICE-2:Letters Q-U In Octave 3"
620 PLOT1,11,"VOICE-3:Letters A-J In Octave 4"
630 PLOT4,13,"The letters on the bottom row"
640 PLOT4,14,"act as on/off switches for"
650 PLOT4,15,"the different combinations of"
660 PLOT4,16,"the three sound channels."
670 PLOT5,17,"Z-ALL OFF,X-1 ON,C-2 ON,"
680 PLOT5,18,"V-3 ON,B-1&2 ON,N-1&3 ON,"
690 PLOT5,19,"M-2&3 ON,L-1,2&3 ON."
700 PLOT1,22,"TO STOP THE PROGRAM PRESS THE SPACE BAR"
710 RETURN
```

(continued from page 165)

```
248 IFLL=5THENIFH=9:8120THENLL=0:POKEH,32:POKEH-22,32
250 GOTO180
500 X=L:F=INT(RND(2)*12) :AZ=INT(RND(3)*2) :IFAZ=1THENAZ=-1
505 IFAZ=0THENAZ=1
510 XX=X*(F*22) :IFAZ=-1THENX=X-3
520 RETURN
800 POKEV+2,200:O=32
810 FORJJ=1TO10:POKEV-10,36:FORI9=1TO60:NEXT:POKEV-10,38:SYS680
811 FORI9=1TO60:NEXT:NEXT:POKEV+2,0:POKEV+2,0 POKEX-1,0:POKEX+1,0:POKEX,0
820 IFAZ=1THENLL=0:POKEH,0:POKEH-22,0:SC=SC+10:GOSUB500:GOSUB700:GOTO630
821 IFAZ=-1THENLL=0:POKEH,0:POKEH-22,0:SC=SC+10 GOSUB500:GOSUB700
830 POKESS,39:SS=SS-1:GOTO180
700 PRINT"#3SCORE    ■■■■■"SC:RETURN
800 FORHH=680TO680+52:READ ZZ#
810 GG=#5C(ZZ#)-48:II=#5C(RIGHT$(ZZ#,1))-48
830 IFGG>16THENGG=GG-7
840 IFII>16THENII=II-7
850 POKEHH,GG*16+II
860 NEXT HH:RETURN
900 FORI9=7724TO7724+21
910 IFPEEK(I9+1)<>32THENH=I9:H=H+KK:POKEH,38:RETURN
920 NEXT:RETURN
930 I9=0:OO=250:FORXX=X-44TO7746STEP-22
935 SYS680
940 POKEXX,42:POKEV,170:POKEV+2,OO:OO=OO-8 POKEXX+22,32
950 IFPEEKXX-22)=330RPEEKXX-22)=34THENI9=5
960 IFI9=5THENSC=0:POKEXX-22,40:POKEXX-21,41 FORJJ=255TO128STEP-.5:POKEV,JJ:NEX
T
961 IFI9=5THENPOKEXX-22,32:POKEXX-21,32:POKEV+2,0:POKEV,0 I9=0
970 NEXT:POKEV+2,0 POKEV,0
980 POKEXX,32 PRINT"#3■■■■■
```

```
10 'LISTING 1 -- BUBBLES -- D.BERRY
20 '*****************************
30 CLS8
40 XGUN=6:MOVE=-5:HIT=0:DAMAGE=0
50 GUNTITY=5:RAD=15:RCC=1:GAME=1
60 DIM MB(8,8),X(GU),Y(GU),VEL(GU),RAD(GU),GUN(10,12),BLANK(10,12),G%(4),CLOUD(2
6,8),BCLOUD(26,8)
70 REM PARAMETERS
80 C0=65280:C1=223:C2=-5:C3=+5:C4=-2:C5=+2:C6=178:C7=190:C8=240:C9=157:K0=138:K1
=150:K2=26
90 G%(1)="BM206,2,"
100 G%(2)="BM211,2,"
110 G%(3)="BM216,2,"
120 G%(4)="BM221,2,"
130 PMODE4:SCREEN1,0:COLOR 0,1:PCLS
140 GET(8,0)-(26,8),BCLOUD,G
150 DRAW"BM5,5;F2R16E2U1H3L8G1L4H4L5G4D2R6"
160 PRINT(10,6)
170 GET(0,0)-(26,8),CLOUD,G
180 PUT(0,0)-(26,8),BC,PSET
190 GET(20,179)-(28,187),MB,G
200 LINE(0,0)-(255,191),PSET,B
210 PLAY"T10;ABCDEDCBA;T255"
220 TTL=GU-1
230 GOSUB 310
240 GOSUB 420
250 GOSUB 1170
260 GOSUB 1040
270 GOSUB 650
280 GOSUB 470
290 IF TTL>1 GOTO 270
300 IF TTL=1 THEN GAME=GAME+1:RAD=RAD*0.75:MOVE=-5:XGUN=3:RCC=RCC-0.25:IF RCC(0.5 TH
EN RCC=0.5:PCLS:GOTO 200 ELSE PCLS:GOTO 200 ELSE PLAY"T5;O3DDDDD28":PRINT(2,190):
CLS(GA):PRINT"YOU LOST":PRINT"YOU SCORED ";PRINT FIX(DA);" POINTS":PRINT HIT;"D
ESTROYED":END
310 REM DCIRC:DRAW CIRCLES
320 XCLOUD=0
330 FOR Q=1 TO GU
340 X(Q)=RND(255-2*RAD)+RAD
350 Y(Q)=RND(48-RAD)+RAD
360 RAD(Q)=RAD
370 VEL(Q)=15/RAD
380 IF X(Q)>50 AND X(Q)<150 AND XCLOUD=0 THEN XCLOUD=X(Q)-12
390 NEXT Q
400 IF XCLOUD=0 THEN XCLOUD=175
410 RETURN
420 REM DGUN:DRAW GUN
430 DRAW"BM3,190;R8BU1L8BU1R8BU1L8U3;BM7,186;UBR1D8"
440 GET(3,178)-(13,190),GUN,G
450 GET(20,174)-(30,186),BLANK,G
460 RETURN
470 REM MCIRC:MOVE CIRCLES
480 TIMER=0
490 PUT(X(.K),Y(.K))-(X(.K)+K2,K0),BC,PSET
500 X(.K)=X(.K)+(RND(3)-2)
510 PUT(X(.K),Y(.K))-(X(.K)+K2,K0),CL,AND
520 RN=RND(GU)
530 IF RAD(RN)<1 GOTO 630
540 CIRCLE(X(RN),Y(RN)),RAD(RN),1
550 PSET(X(RN),Y(RN))
560 Y(RN)=Y(RN)+VEL(RN)
570 IF Y(RN)>180-RAD(RN) GOTO 300
580 X(RN)=X(RN)+(RND(7)-4)
590 IF X(RN)<10 THEN X(RN)=10
600 IF X(RN)>243 THEN X(RN)=243
610 CIRCLE(X(RN),Y(RN)),RAD(RN),0
620 PSET(X(RN),Y(RN))
630 IF TIMER<15 THEN GOTO 630
640 RETURN:TIMER CONTROLS SMOOTH GUN MOVEMENT
650 REM MGUN:MOVE GUN
660 IF PEEK(C0)=C1 THEN PLAY"C":GOSUB 850
670 MG$=INKEY$
680 IF MG$=" " GOTO 730
690 IF MG$="," THEN MOVE=C2
700 IF MG$="." THEN MOVE=C3
710 IF MG$="M" THEN MOVE=C4
720 IF MG$="/" THEN MOVE=C5
730 PUT(XGUN,C6)-(XGUN+10,C7),BLANK,PSET
740 XGUN=XGUN+MOVE
750 IF XGUN<C8 OR XGUN>C3 THEN MOVE=-MOVE
760 IF XGUN<0 THEN XGUN=6
770 PUT(XGUN,C6)-(XGUN+10,C7),GUN,PSET
780 RETURN
790 REM FIRE:FIRE GUN
800 TIMER=0
810 LINE(OF,C6)-(OF,YGUN),PSET
820 PLAY"D"
830 LINE(OF,C6)-(OF,YGUN),PRESET
840 RETURN
850 REM HIT? -- DRAW CUT
860 YMRKW=INTEST*40:OF=XGUN+4
870 FOR Q=1 TO GU
880 IF RAD(Q)=0 GOTO 920
890 IF(OF-(RAD(Q)*RCC)<X(Q)) OR (OF-(RAD(Q)*RCC)>X(Q)) GOTO 920
900 HTEST=1
910 IF Y(Q)>YMRK THEN YMRK=Y(Q):K=Q
920 NEXT
930 IF HTEST=0 THEN YGUN=1 ELSE YGUN=Y(K)
940 IF OF>X( THEN IF X(<X(+22 THEN IF Y(<C9 THEN Y(=K:GOSUB 790:RETURN
950 GOSUB 790
960 IF YGUN=1 THEN RETURN
970 REM RUB OUT & REDRAW
980 CIRCLE(X(K),Y(K)),RAD(K),1
990 RAD(K)=FIX(RAD(K)/2)
1000 VEL(K)=VEL(K)*2:X(K)=X(K)+(RND(7)-4)
1010 IF RAD(K)>0 THEN CIRCLE(X(K),Y(K)),RAD(K),0 ELSE HIT=HIT+1:PRESET(X(K),Y(K)
):X(K)=0:TTL=TTL-1:GOSUB 1170
1020 DA=DA+(VEL(K)*RCC):GOSUB 1040
1030 RETURN
1040 REM DCOUNT:PRINT DAMAGE TALLY
1050 PUT(206,2)-(214,10),MB,PSET
1060 PUT(216,2)-(224,10),MB,PSET
1070 DX=DA:SCALE=1000
1080 FOR LOOP=1 TO 4
1090 A%=Q%(LO)
1100 BB=DX/SCALE
1110 GOSUB 1350
1120 DX=DX-BB*SCALE
1130 SCALE=SCALE/10
1140 NEXT
1150 PLAY"C"
1160 RETURN
1170 REM HCOUNT:HIT TALLY
1180 A%="BM193,2,"
1190 PUT(193,2)-(201,10),MB,PSET
1200 BB=TTL-1
1210 GOSUB 1350
1220 A%="BM181,2,"
1230 PUT(181,2)-(189,10),MB,PSET
1240 BB=GAME
1250 GOSUB 1350
1260 A%="BM236,2,"
1270 PUT(236,2)-(244,10),MB,PSET
1280 BB=FIX(HIT/10)
1290 GOSUB 1350
1300 A%="BM241,2,"
1310 BB=HIT-(FIX(HIT/10)*10
1320 GOSUB 1350
1330 PLAY"RDR"
1340 RETURN
1350 REM PRINT:PRINT ON SCREEN
1360 ON BB GOTO 1380,1390,1400,1410,1420,1430,1440,1450,1460
1370 A%="R3D7L3U7":GOTO 1470
1380 A%="BM+3,0/D7":GOTO 1470
1390 A%="R3D3L3D4R3":GOTO 1470
1400 A%="R3D7L3R3U4L3":GOTO 1470
1410 A%="D3R3U3D7":GOTO 1470
1420 A%="R3L3D3R3D4L3":GOTO 1470
1430 A%="R3L3D7R3U4L3":GOTO 1470
1440 A%="R3D7":GOTO 1470
1450 A%="R3D3L3U3;BM+0,+3/D4R3U4":GOTO 1470
1460 A%="R3D3L3U3R3D7":GOTO 1470
1470 DRAW A%+B$
1480 RETURN
```

(continued from previous page)

PMode4. In the lower modes the circles are approximate to such an extent that with radii below about 15 their finned square shapes make useful gunsights. The Draw command is always followed by a string literal or variable which controls the movement of an imaginary cursor — up, down, left, right; plus diagonals, rotation, scaling and blank moves any number of screen points.

The gun and cloud are formed initially with the Draw command then moved around with Put and Get. The score digits are produced by concatenating strings containing draw instructions with ones containing blank move instructions then using the result as the argument for a Draw command.

Get copies graphical data from the screen and stores it in a predefined array. Put reverses the process. Put and Get are used in Bubbles to move the gun and cloud, the sequence being simply: Put blank sky where the gun is now; change the X co-ordinate of the gun; Put the gun in its new place. the cloud is moved in the same way.

The program is broken down into a series of subroutines starting with DCirc in line 310. Lines 10 to 220 perform the initial setting up, draw the screen, and cloud, set tally and score counters and set up a parameter list.

The arrays used by the program are as follows: MB stores a bit of blank sky used here and there to rub out characters and so on, X and Y are circle centres, Vel is circle 'velocity", Rad is radius, Gun has the drawn "gun" Put and Get from it, Blank is again blank sky — this time big enough to rub out the gun, and Cloud and BCloud are similar to Gun and Blank. It is important to note that Dragon Basic only recognises the first two letters of a variable name so that, for example, Bcloud and BC are the same variable. Lines 150 and 160 use Draw and Paint to fashion the nasty black cloud.

DCirc sets up each circles' variables: X,Y,Rad and Vel. It also ensures the cloud is directly in front of one of the bubbles. DGun draws the gun and stores it in array Gun.

MCIRC first moves the cloud then draws out, moves and redraws a randomly chosen circle. Line 570 asks "has a bubble reached the ground?" then jumps to a line which terminates the program if true.

MGun scans the keyboard and jumps to Hit if the fire key is being pressed. Notice the extensive use of parameters in this often used routine. Fire simply draws the line of "laser light" from "gun" to "target". This is called from Hit which calculates whether a bubble was in the way of the shot. It uses the present Accuracy and Radius values to perform the calculation. This routine produces a parameter YGun to pass into Fire which then draws its line to the point XG,YG. Lines 970 onwards change the parameters of a hit bubble. Radius is halved velocity doubles and its centre jumps sideways.

DCount and HCount are respectively damage and hit tallies. They break the number passed to them into individual digits then use routine Print to display the values on the screen.

Worm squirm

J S Henry,
Cranleigh,
Surrey.

ATOM

THIS PROGRAM is called Worm and it runs on a fully expanded Acorn Atom in 4K. The

(continued on page 173)

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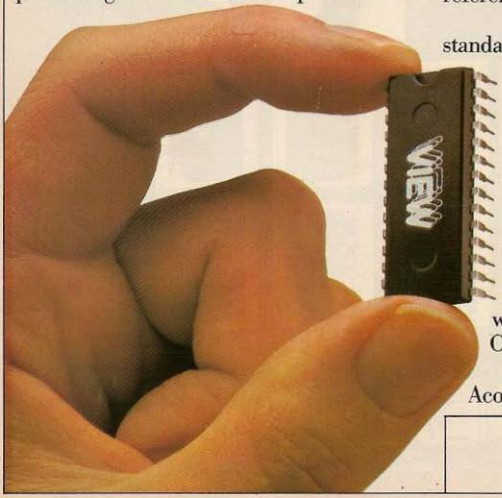

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(continued from page 168)

object of the game is to eat the zeros and miss the dots. There are always two zeros on the screen and when you eat one, another one appears.

If you hit one of the dots a section of your tail is cut off and another dot appears. Dots also appear after you have eaten 3 zeros. If you run into your tail or the sides you will lose a point. The game ends when you either run out of tail or trap yourself in your tail. The dots move randomly one at a time and there are machine-code sound effects.

Use j to turn you left and k to turn you right. To master the turning always imagine yourself at the head of the worm looking the direction you are always travelling. Make sure also that you do not keep the button down too long or you will turn too far. Here is a breakdown of the program:

1-95	: set up screen and machine code
100-160	: move worm
1000-1030	: set up zero
1100-1120	: set up dots
1200-1250	: check if dead end or trapped
1290-1370	: game over routine
1500-1530	: move a dot at random
1999-end	: instructions.

```
   1805.P
   2T=0;E=0
    5T%DI=2;I=0;R=%IBF0;$R="GO? "
   10?%E1=0;CLEAR0;S=1;IFNC10RR>9999;H=0
   20MOVE0,0;DRAW63,0;DRAW63,47;DRAW0,0
   30DIM%G22,EE20,W05;P=%IB00-P.#22
   40L=%B002;I;W00JSRWEF17;ST?%B0;RTS
   50:VUIL0?%B2;:VU2LDX#B0
   60:VU2TXS;%WEVU2
   70STAL;EORX4;DEY;BNEVU2;RTS;J
   80P.$n;M=15
   90FOR8=170M;A8&=%B020+8;?A8&=-1;N.
   91FOR8=255TO1S,-4;?%B0+8;LINKVU1;WAIT;N.
   95805.a;805.a;?%B1=20
   100?A%=162
   101LINKVU0;Z=?%B0+32;?%B002=Z
   115805.>
   120I%=A%?%B4;IFA%%7-1?64;IFA%%32>64;IFA%%-32>64;G.0
   125IT=0
   220DI?%B4=4;805.e;IF%=0;G.0
   230FOR8=%T02555.36;?%B0+8;LINKVU1;N.;T=T
   240IT4%DI4%DI4=0;F.8=170TO;?%B0+%D;LINKVU1;N.;S=S-1;R.
   250R.
   290A?%B1=2
   300CLEAR4;FORS=170200;?%B000+%F0;?%B0+8;LINKVU1;?%B000+%F0;N.
   305P.$12"game over""YOUR SCORE WAS";IF=S;N=S
   310P."HISCORE:              %H"
   330FOR8=255TO05,-8;?%B0+8;LINKVU1;N.
   335?%B1=20;FORE=170255.3
   340?%B0+8;LINKVU1;?%B0+8-10;LINKVU1;?%B0+8+10;LINKVU1
   350N.;P."PRESS ANY KEY TO RESTART"
   360?%B0=%D;?%B1=3;LINKVU0;IF?%B0<255;G.2
   1000.Z=0
   1010?%B0=Z;?%B1=Z;?%B2=Z;?%B3=Z;?%B4=Z;?%B5=Z;?%B6=Z;?%B7=Z;?%B8=Z;?%B9=Z;?%B10=Z;?%B11=Z;?%B12=Z;?%B13=Z;?%B14=Z;?%B15=Z;?%B16=Z;?%B17=Z;?%B18=Z;?%B19=Z;?%B20=Z;?%B21=Z;?%B22=Z;?%B23=Z;?%B24=Z;?%B25=Z;?%B26=Z;?%B27=Z;?%B28=Z;?%B29=Z;?%B30=Z;?%B31=Z
   1020?%B32=Z;?%B33=Z;?%B34=Z;?%B35=Z;?%B36=Z;?%B37=Z;?%B38=Z;?%B39=Z;?%B40=Z;?%B41=Z;?%B42=Z;?%B43=Z;?%B44=Z;?%B45=Z;?%B46=Z;?%B47=Z;?%B48=Z;?%B49=Z;?%B50=Z;?%B51=Z
   1030?%B52=Z;?%B53=Z;?%B54=Z;?%B55=Z;?%B56=Z;?%B57=Z;?%B58=Z;?%B59=Z;?%B60=Z;?%B61=Z;?%B62=Z;?%B63=Z;?%B64=Z;?%B65=Z;?%B66=Z;?%B67=Z;?%B68=Z;?%B69=Z;?%B70=Z;?%B71=Z
   1100?%B0=170;A8&=%B020+8;?A8&=-1;N.
   1105E=E+1;EEE=6
   1110?%B0=%D;?%B0=170TO;LINKVU1;WAIT;N.
   1120R.
   1200I?%B0=25;805.a;R.
   1250R.
   1290A?%B1=2
   1300CLEAR4;FORS=170200;?%B000+%F0;?%B0+8;LINKVU1;?%B000+%F0;N.
   1305P.$12"game over""YOUR SCORE WAS";IF=S;N=S
   1310P."HISCORE:              %H"
   1330FOR8=255TO05,-8;?%B0+8;LINKVU1;N.
   1335?%B1=20;FORE=170255.3
   1340?%B0+8;LINKVU1;?%B0+8-10;LINKVU1;?%B0+8+10;LINKVU1
   1350N.;P."PRESS ANY KEY TO RESTART"
   1360?%B0=%D;?%B1=3;LINKVU0;IF?%B0<255;G.2
   1400?%A%=64;FORS=170
   1410?%B0=%D;LINKVU1;?%B0=255-8;LINKVU1;N.;H=H-1;P.
   1500X0=R.RI.E=2
   1510S=EO=R.I2=R.I2=I2
   1520IF?%B0<64;R.
   1530?%E0=64;?%B=4;E0=%;R.
   1999P.
   2000P.$10"*****************HOW*****************"
   2010P.""YOU ARE AT THE HEAD OF THE WORM.""YOU MUST EAT THE "
   2020P."'O'S.IF YOU HIT THE DOTS YOU WILL LOSE PART OF YOU TAIL"
   2030P."MAKE SURE YOU DON'T RUN INTO YOUR TAIL OR THE WALLS OR"
   2040P." YOU MIGHT TRAP YOURSELF "
   2050P."USE 'J' TO MOVE LEFT AND 'K' TO MOVE RIGHT"
   2060P."GOOD LUCK""PRESS ANY KEY TO CONTINUE";L1.#?E0
   2070R.
```

Flight of Fancy

M J Parrot,
Stockport,
Cheshire.

BBC

THE GAME is for the Model B and is the traditional 501 down, finishing on a double or the bull. Lines 10,220 give the instructions for the game, ask the number of players and take in the names of the players. If there is only one, then player 2 is assigned the name Beeb (line 210) and the logical variable Beeb is set Trüe.

After pressing the space bar (lines 230,240) the game can begin but we first have to draw the board. This is the most complicated part of the program because some trigonometry is used. Line 1170 first sets minimum and maximum values for X and Y so that the cross-hair cannot wander off the edge of the screen. The two variables Dif and Mote are used to draw the cross-hair and move it around the board. Line 1180 Reads the scores for each sector of the board into an array S in a counter-clockwise fashion beginning and ending with the 6 (at three o'clock). The origin of the graphics page is set to the centre of the screen and we are set for drawing sectors and circles around this central point. The radii which delimit the bull, the outer bull, the trebles and the doubles are set in line 1200 and two variables C and S are set to the cosine and sine respectively of 0.02 of Pi because the sectors are drawn recursively to save time. I used the triangle fill mode to draw five pairs of triangles in each segment since this nicely fills the screen leaving a clear image without unlit pixels.

The main part of the board is drawn by a pair of nested For-Next loops. The outer loop — lines 1210-1280 — steps around the board in steps of 18 degrees.

The inner loop — lines 1230-1260 — draws four segments within each sector by calling Procedure Sector. Within this loop the colour is changed alternatively between the two logical, graphical foreground colours 0 and 1 by the line 1240 which uses the variable K which was initially set in line 1200. On leaving the inner loop the logical colour is once more changed to allow for the start of the next sector.

Procedure Sector Moves the graphics cursor to the start X,Y of the segment and Draws the leading edge up to the point X1, Y1. The third point of the triangle 1 is calculated recursively and the triangles are filled in. The next

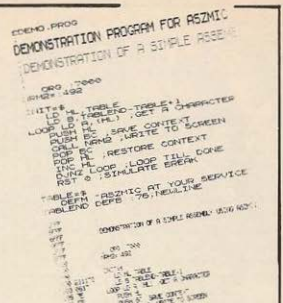
(continued on page 175)

```
   10 MODE1:COLOUR2:COLOUR128:REEP=FALSE
   20 DIM8(4,3),S(20),SCORE(1),PLAYER(2,DARTS(3),NAMES(1)
   30 PRINTTAB(15,2)"BEEB DARTS"
   40 COLOUR3
   50 PRINT:PRINT"The game is 501 down"
   60 PRINT"Finish on a double or the bull."
   70 COLOUR1
   80 PRINT:PRINT"AIMING"
   90 COLOUR3
   100 PRINT:PRINT"Up.....A          Down.....Z"
   110 PRINT:PRINT"Left...K          Right....L"
   120 PRINT:PRINT:PRINT"Throw with the space bar"
   130 PRINTTAB(5,20)"Hit! there is no ";"?"
   140 REPEAT
   150   A$=GET$
   160   UNTIL A$=CHR$(32)
   170 IF A$=CHR$(32)THENSCORE=TRUE
   180 PRINTTAB(5)"What's the name of player 1"
   190 INPUT NAME$(0)
   200 IF NOT BEEB THENPRINTTAB(5)"What's the name of player 2";INPUTNAME$(1)
   210 IF BEEB THENPRINT"The BEEB will be player 2"INPUTNAME$(1)"BEEB"
   220 PRINT:PRINT"PRESS THE SPACE BAR TO PROCEED"
   230 REPEAT
   240   A$=GET$:UNTIL A$=" "
   250 MODE1:GCOL0,170:CLS:COLOUR130:COLOUR0
   260 PROCBOARD
   270 FINISH=FALSE
   280 REPEAT
   290   FORPLAYER=0TO1:SCORE(PLAYER)=0:PROCWRITESCORE
   300   IF(NAME$(PLAYER)).AT.BEEBWHEREPLAYER=1ELSEIF(NAME$(PLAYER).A
   310   NEXT
   320   PLAYER=1
   330   GAMEOVER=FALSE
   340   REPEAT
   350     PLAYER=ABS(PLAYER-1):DART=0:TSCORE=0
   360     PROCWRITENAME
   370     REPEAT
   380       DART=DART+1
   390       DOUBLE=FALSE:DUST=FALSE:WIREFLAG=FALSE
   400       X=RND(470)-235:Y=RND(470)-235
   410       PROCMOVECROSS
   420       IFPOINT(X,Y)=BAND RND(7)=2THEN WIREFLAG=TRUE
   430       PROCDART(X,Y)
   440       X=X15.1
   450       PROCTHUD
   460       PROCSCORE
   470       IFRND(1) OR RND(5)THENWIREFLAG=FALSE
   480       PROCWRITEBUB
   490       PROCTOTALTSE
   500       UNTIL DART=3 OR GAMEOVER OR BUST
   510     IF NOT BUST THENSCORE(PLAYER)=SCORE(PLAYER)-TSCORE
   520     PROCBUST
   530     X=X15.1
   540     PROCCLEARBOARD
   550     PROCWRITESCORE
   560     UNTILGAMEOVER
   570   PROCWRITEWIN
   580   REPEATA$=GET$UNTIL A$="Y"OR A$="N"
   590   IFA$="Y"THENFINISH=TRUE
   600   PROCWRITEWD
   610   VDU4
   620   UNTIL FINISH = TRUE
   630 MODE1:PRINTTAB(10,10)"BYE"
   640 END
   650 DEF PROCSCORE
   670 DARTS(DART)=X:DARTS(DART)=Y
   680 R=SQR((X*X)+(Y*Y)):IFR<8(0)THENSCORE=50:DOUBLE=TRUE:ENDPROC
   690 IFR<8*(1)THENSCORE=25:ENDPROC
   700 IFR<8*(3)THENSCORE=0:ENDPROC
   710 IFR<8*(4)THEN SCORE=0:ENDPROC
   720 THETA=ACS(X/R):IFY<0THENTHETA=2*PI-THETA
   730 THETA=THETA/(2*PI/20):THETA=INT(PI*PI/20)
   740 SCORE=S(THETA):IFR>8*(4)THENSCORE=SCORE*2:DOUBLE=TRUE:ENDPROC
   750 IFR>8*(3)AND>8*(2)THENSCORE=SCORE*3:ENDPROC
   760 ENDPROC
   780 DEF PROCWRITESCORE
   790 IFNAME$(PLAYER)THENPRINTTAB(1+PLAYER*14,25+BAD)"Hiro"ELSEPRINTTAB(1+PLAYER*20
25+DARTS(DARTS
   800 ENDPROC
   820 DEF PROCDART(X,Y)
   830 G=DIF/2
   840 MOVE5-D,Y-D
   850 DRAW5+D,Y+D
   860 MOVE5-D,Y+D
   870 DRAW5+D,Y-D
   880 ENDPROC
   900 DEFPROCMOVECROSS
   910 GCOL3,2
   920 REPEAT
   930   PROCRANDOM
   950   IFX <MIN THEN X=MIN
   955   IFX >MAX THEN X=MAX
   960   IFY <MIN THEN Y=MIN
   970   IFY >MAX THEN Y=MAX
   980   PROCMOVE5
   990   A$=INKEY(10)
   1000  PROCDIFF
   1010  IFA$="J" Y=Y+MOTE
   1020  IFA$="K" Y=Y-MOTE
   1030  IFA$="J" X=X-MOTE
   1040  IFA$="L" X=X+MOTE
   1050  UNTIL REEP AND PLAYER=1THENPROCMOVE5
   1060  UNTILFALSE
```

(listing continued on page 175)

ZX81 MACHINE CODE?

ZX.ASZMIC rom transforms ZX81 into an **Assembly Language** programming unit



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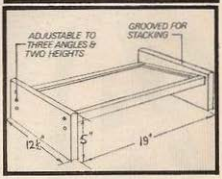

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(listing continued from page 173)

```
1070 ENDPROC
1080 DEF PROCCROSS
1090 MOVE X,Y
1100 DRAWX,Y+DY
1110 MOVEX,Y-DY
1120 DRAWX,Y-DY
1130 ENDPROC
1140 DEF PROCCIRCLE(R)
1150 FRIN=ATN(1MAX*ATN(1MIN-SIN(1MAX*SIN(1D)-SQ(R*R))
1160 FORI=TOCIRCLE600(1)NEXT
1170 VDU29;0;0;29,640;512;
1180 FORI=1TO(R)-SQR(R*R-X*X)STEP1
1190 VDU29;0;0;29,640;512;
1200 FORI=1TO(R)-SQR(R*R-X*X)STEP1
1210 FORI=PI/20TO2*PI-PI/20STEPPI/10
1220  DIM(0)=(X*SIN(I)
1230  FORL=1TO4
1240   GCOLO,K:K=ABS(K-1)
1250   PROCROTOR(R(L)*C1,R(L)*S1,R(L+1)*C1,R(L+1)*S1)
1260   NEXTL
1270  GCOLO,K:K=ABS(K-1)
1280  NEXTI
1290 FORI=PI/20TO2*PI-PI/20STEPPI/10
1300  PRINT$(I)NEXT
1310 GCOLO,2
1320 FORI=PI/20TO2*PI-PI/20STEPPI/10
1330  X=R(5)*COS(I):Y=R(5)*SIN(I)
1340  MOVEO,O:DRAWX,Y
1350  NEXT
1360 FORI=2TO4:PROCCIRCLE(R(I))NEXT
1370 GCOLO,0
1380 C=PI:X=MOVEO,0
1390 FORI=1TO21:X=R(0)*COS(C*(I-1)):Y=R(0)*SIN(C*(I-1))
1400  MOVEX,Y:PLOT85,X,Y
1410  NEXTI
1420 VDU4
1430 ENDPROC
1440 DEF PROCSECTOR(X,Y,R,V)
1450 MOVEX,Y:DRAWX,Y
1460 FORI=1TO5
1470  T=X*C-Y*S:Y=X*S+Y*C:X=T
1480  PLOT85,X,Y
1490  T=X*C-Y*S:Y=X*C+Y*S:X=T
1500  PLOT85,X,Y
1510  NEXTI
1520 ENDPROC
1530 DEF PROCTOTALISE
1540 IFSCORE=SCORE(PLAYER)-TSCORE ANDDOUBLE=TRUE THEN GAMEOVER=TRUE:ENDPROC
1550 IFSCORE<=SCORE(PLAYER)-TSCORE-1THENPROCBUST:ENDPROC
1560 TSCORE=TSCORE+SCORE
1570 ENDPROC
1580 DEF PROCBUST
1590 SOUND 1,-15,100,10
1600 BUST=TRUE
1610 ENDPROC
1620 DEF PROCRETSCORE
1630 FLAG=FALSE:SCORE=SCORE(PLAYER)
1640 IFSCORE<41AND(SCORE/2-INT(SCORE/2))<>1THENSCORE=SCORE/2:FLAG=TRUE
1650 PRINTTAB(14,PLAYER*2,4)" "
1660 PRINTTAB(14,PLAYER*2,4)SCORE;
1670 IFFLAG PRINT "*"
1680 ENDPROC
1690 DEF PROCCLEARDOWN
1700 FORI=1TODART
1710  PROCDART(DARTX(I),DARTY(I))
1720  PRINTTAB(14,PLAYER*2,4)" "
1730  PROCDART
1740  NEXTI
1750 ENDPROC
1760 DEF PROCINIT(GAME)
1770 FORI=1TO4
1780  READR(I)
1790 ENDPROC
1800 DEF PROCCIRCLE(R)
1810 C=COS(0.05):S=SIN(0.05):X=R:Y=0
1820 MOVEX,Y
1830 FORJ=1TO20:T=X*C-Y*S:Y=X*S+Y*C:X=T
1840  DRAWX,Y
1850  NEXTJ
1860 ENDPROC
1870 DEF PROCDART
1880 FORI=0TO10000:NEXTI
1890 ENDPROC
1900 DEF PROCINIT
1910 FORI=0TO10000:NEXTI
1920 ENDPROC
1930 DEF PROCMYGAME
1940 PROCINIT
1950 A$=" "
1960 IF SCORE(PLAYER)-180THENX=0:Y=R(2)*16:PROCRANDOMEND PROC
1970 IF SCORE(PLAYER)-TSCORE-100THENX=0:Y=R(3)*25:PROCRANDOMEND PROC
1980 IF SCORE(PLAYER)-TSCORE-61THEN X=50:Y=R(3)*50:PROCRANDOMEND PROC
1990 IFSCORE(PLAYER)-TSCORE=50THENX=0:Y=0:PROCRANDOMEND PROC
2000 IF SCORE(PLAYER)-TSCORE-40THENX=R(3)*30:Y=0:PROCRANDOMEND PROC
2010 IF SCORE(PLAYER)-TSCORE-1THEN X=0:Y=0:PROCRANDOMEND PROC
2020 IFSCORE-TSCORE-1THEN SCORE=1 :1THEN1=0:REPEATI=I+1:UNTILSCORE=S(I):THETA=PI*I/10-PI
2030 FORI=1TO5:X=R*COS(THETA):Y=R*SIN(THETA):DIRECTX=X:Y=Y*3D
2040 PROCRANDOM
2050 ENDPROC
2060 DEF PROCRANDOM
2070 D=RND(3)-2:E=RND(3)-2
2080 X=X+D*15:Y=Y+E*15
2090 ENDPROC
2100 DEF PROCWRITEND
2110 PRINTTAB(1,21)" "
2120 VDU5:GCOL3,3
2130 FORA=0TO4:PRINTTAB(RNUMBER, 7)
2140 PRINTNAME$(PLAYER)
2150 PRINT"ANOTHER GAME?"
2160 PRINT"Y/N"
2170 ENDPROC
2180 DEF PROCWRITEMSG
2190 IFPLAYER=0THENPRINTTAB(12,21)"                    "ELSEPRINTTAB(1,21)"
2200 SOUND1,-15,100,7
2210 PRINTTAB(14*SMPLAYER,2)NAME$(PLAYER)
2220 ENDPROC
2230 DEF PROCTURN
2240 SOUND1,-15,100,5
2250 ENDPROC
2260 DATA0,0,0,
```

(continued from page 175)

shown in the diagram, the keys from Z to the oblique stroke acting as normal notes and the keys S, D, G, H, J, L and , acting as the sharps. The same is true for the top two rows of keys. The sharps are on 2, 3, 4, 6, 7, 9, 0, +, £ and the CLR/HOME key. This gives a range of just over three octaves.

The waveform can either be triangle, sawtooth, pulse or noise. These govern the shape of the sound wave. The attack-decay and sustain-release determine how long it takes for a note to reach its peak volume — attack — to fall from its peak volume to sustain level — decay — how long it stays at this level — sustain — and how long the note takes to fall from the sustain level — release.

The waveform can be changed during the running of the program by using the function keys (see program listing). The instructions are contained in lines 10-95. Lines 100 to 230 read in the high and low frequency values into an array. The place in the array into which the note is placed is governed by the value in the keyboard buffer (location 197) for that key. The main locations are:

54296-Volume control
54273-High frequency
54272-Low frequency
54276-Waveform
54275-High pulse
54274-Low pulse
54277-Attack/Decay
54278-Sustain/Release

These locations are used for voice one only, voices 2 and 3 have different locations. In Line 462, Poke 198,0 clears the keyboard buffer after each key.

(listing continued from page 175)

```
150 DATA27,56,25,177,0,0,30,141,8,147,9,21,28,214
160 DATA0,0,0,0,32,94,10,60,36,85,10,205
170 DATA0,0,34,75,9,159,40,200,38,1,26,12,32
180 DATA0,0,12,216,12,156,42,52,11,214,48,127
190 DATA45,198,15,70,54,111,16,47,0,0,51,97
200 DATA14,187,61,126,57,172,18,42,0,0
210 DATA19,63,20,100,64,88,17,37,72,169,68,149
220 DATA0,0,81,161,0,0,0,0,76,250,21,154
230 DATA0,0,0,0,0,0,24,62,0,0,0,0,22,227,0,0
240 VOL=54296
250 HFR=54273
260 LFR=54272
270 WFR=54276
280 HPE=54275
290 LPE=54274
300 AD=54277
310 SR=54278
320 PRINT"WAVEFORM:"
330 PRINT"17 = TRIANGLE"
340 PRINT"33 = SAWTOTH"
350 PRINT"65 = PULSE"
360 PRINT"129=NOISE"
365 INPUT#
370 INPUT"ATTACK/DECAY";L(1)
380 INPUT"SUSTAIN/RELEASE";L(2)
390 IFR=65THEN4:20
400 INPUT"HIGH PULSE (0-15)";P(1)
410 INPUT"LOW PULSE (0-255)";P(2)
420 REM**KEYBOARD SCAN**
430 POKEVOL,15
435 POKELPE,P(2) POKEHPE,P(1)
440 POKEAD,L(1)
450 POKESR,L(2)
455 POKEWFR,F
460 IHPEEK(197)
462 POKE198,0
463 GOSUB2000
465 IFS=0THENPOKEVOL,0 POKEWFR,0 POKEAD,0 POKESR,0
    GOTO9999
470 IFS=4THEN460
500 POKEHPFR,HO(S-1)
510 POKELFR,HO(S-1)
515 IFPEEK(197)=6THEN515
520 POKEWFR,0
540 GOTO430
600 POKEVOL,5
610 GOTO430
1000 IFS=4THEN#17
1010 IFS=5THEN#33
1020 IFS=6THEN#65 GOTO430
1030 IFS=7THEN#129
2040 RETURN
2050 POKEAD,0 POKESR,0 POKEWFR,0
9999 PRINT"T
```

Tape examiner

M Salmon,
Abingden,
Oxfordshire.

SPECTRUM

THE SPECTRUM saves files as two blocks — header and data. The data may be of any length and could represent anything, so the header is needed to tell the Spectrum how to interpret the data. The header is composed of 17 bytes, as follows:

offset	description
0	file type: 0 = program, 1 = number array, 2 = string array, 3 = bytes
1-10	filename in ASCII
11-12	total length in bytes of data to be read in
13-14	special
15-16	program length in bytes

Bytes 13 and 14 are used for any specific information required. For type 0 files it contains the auto-run line number — unless it is more than 32767 which signifies load only. For type 3 files it contains the start address for Load "" Code with no parameter. For types 1 and 2 only byte 14 is used. This contains packed information for the aid of the floating point calculator. Bits 0-4 give the ASCII code minus 64 of the original array saved and bit 6 tells what type of array it is (0 = number, 1 = string). Bit 7 is always set.

The table above is given with offsets as the method used for reading files from tape is by calling a routine with a buffer pointed to by the 16 bit index register IX.

The program contins a small machine routine to do this:

```
175          XOR A
55           SCF
221,33,16,127  LD IX,32528
205,86,5     CALL 1414
201          RET
```

This is set up by lines 10-30. Line 40 sets B to point to the buffer and sets up a user-defined function to extract a double-byte number from an offset X.

Line 50 calls the machine-code subroutine and the Spectrum waits for a header to come in from the cassette port.

```
  10 CLEAR 32511
  20 FOR a=32512 TO 32521: READ
b: POKE a,b: NEXT a
  30 DATA 175,55,221,33,16,127,2
05,86,5,201
  40 LET b=32528: DEF FN a(x)=PE
EK (b+x)+256*PEEK (b+x+1)
  50 RANDOMIZE USB 32512
  60 LET c=PEEK b
  70 IF c>3 THEN GO TO 50
  80 PRINT "Filename: ";
  90 FOR a=b+1 TO b+10: PRINT CH
R$ PEEK a;: NEXT a
 100 PRINT : PRINT TAB 4;"Type:
"
 110 GO SUB 1000+100*c
 120 PRINT : PRINT
 125 POKE b,255
 130 GO TO 50
1000 PRINT "Program"
1010 PRINT "Total length: ";FN a
(11);" bytes"
1020 PRINT "Program length: ";FN
a(15);" bytes"
1030 IF FN a(13)>9999 THEN PRINT
"Load only": RETURN
1040 PRINT "Runs from line ";FN
a(13)
1050 RETURN
1100 PRINT "number array"
1110 LET a$="": GO TO 1200
1200 PRINT "character array"
1210 LET a$="$"
1220 PRINT "Array length: ";FN a
(11);" bytes"
1230 LET d=PEEK (b+14)
1240 PRINT "Original array name:
";CHR$ (64+32*d/32-INT (d/32))
);a$
1250 RETURN
1300 IF FN a(11)=6912 AND FN a(1
5)=16384 THEN PRINT "Screen imag
e": RETURN
1310 PRINT "bytes"
1320 PRINT "Start address: ";FN
a(13)
1330 PRINT "Length: ";FN a(11);"
bytes"
1340 RETURN
```

Line 60 extracts the filetype and line 70 skips the output section if it decides that this is not a header. Lines 80-100 print the filename and line 110 chooses the appropriate routine to use for decoding on the basis of the filetype. This means that it is vitally important that the routines starting at lines 1000, 1100, 1200 and 1300 remain at these lines — otherwise numbering is unimportant. Line 1300 is the only other interesting point — it automatically decides whether a bytes file is a screen image or not.

Spectrum owners with an understanding of machine-code and a good disassembler should find the area of the ROM between 4C2 and 9F3 — hex — interesting to inspect as the tape-handling routines are self-contained. I would advise starting at 605 hexadecimal as this is the highest level of tape handling. The prospective decoder should be helped by the knowledge that the low byte of TADDR will contain a byte ranging from E0-E3 corresponding to the keywords Save, Load, Verify and Merge respectively.

Memory man

TR Carey,
Southampton,
Hampshire.

ZX-81

IF YOU want to know how much memory has been used by various things this program will run on any ZX-81 but it is not really suitable for the 1K machine as the memory is very limited. Using the memory map on page 177 of the ZX-81 manual and the systems variables on pages 177/9. The systems variables are used to find the addresses of different parts of the memory. This program is very useful when writing programs and it can be removed afterwards.

```
9996 PRINT TAB 8;"ZX 81 MEMORY",
,,"TOTAL RAM",,(PEEK 16388+256*P
EEK 16389)-16384)/1024;" K"
9997 PRINT ,,"BASIC PROGRAM",,(PE
EK 16396+256*PEEK 16397)-16509;"
BYTES"
9998 PRINT ,,"VARIABLES",(PEEK 1
6404+256*PEEK 16405)-(PEEK 16400
+256*PEEK 16401)-1;" BYTES"
9999 PRINT,, "SPARE MEMORY",(PEE
K 16388+256*PEEK 16389)-(PEEK 16
404+256*16405);" BYTES"
```

Definer

Brian Etherington,
Hanslope,
Milton Keynes.

BBC

THIS IS A MULTICOLOUR character definer for a 32K BBC Micro. The cursor is moved around an eight by eight grid to define a new character. As new pixels are added or deleted from the new character, the VDU statement parameters are updated on the right-hand side of the grid, in line with each of the eight grid rows. Similarly, the character is displayed in mode 2 graphics to the left of the larger grid. At the bottom of the screen in a 16-colour paint palette, the current ink colour is indicated by the arrow. The ink colour is changed by pressing the space bar. In this

(continued on page 179)

THE CURSE

"Know, Oh Prince . . .
There was a time when the world cowered in the shadow of the Dark Ring, Shedir, and the people cried out for a hero."

THE LEGEND

". . . and it was foretold that a hero would come at last. An adventurer, maybe a great wizard or yet a lowly thief, maybe the son of man or mayhap of elvenkind . . ."

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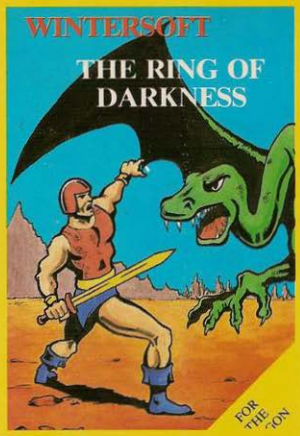

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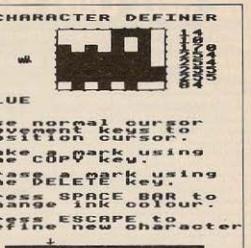
(continued from page 176)

way, overlaid multicoloured graphics characters may be defined and automatically displayed. The VDU parameters are displayed for each colour as you step through the paint palette.

The program has been written in fully-structured Basic and makes extensive use of BBC Basic procedures. The only Goto statement in the entire program is at line 140. Note the procedure Cursoron at line 1200 redefines a different form of cursor to that which is normally available. I believe that this program represents a valuable software-development tool for the BBC microcomputer, and is unusual in that it allows for multi-coloured character generation. In addition, the program is an example of good programming technique for those just learning the craft. Multicoloured characters can be printed using the VDU5 and move commands. The following example prints a character in red, white and blue. It assumes that characters 224-226 have been defined by the user:

```
 5 MODE 2
10 BLUE$ = CHR$ 18 + CHR$ 0 + CHR$ 4
20 RED$ = CHR$ 18 + CHR$ 0 + CHR$ 1
30 WHITE$ = CHR$ 18 + CHR$ 0 + CHR$ 7
40 A$ = BLUE$ + CHR$ 224 + CHR$ 8 +
    RED$ + CHR$ 225 + CHR$ 8 + WHITE$ +
    CHR$ 226
50 VDU 5
60 MOVE 640, 512 : PRINT A$
```




```
  10 REM ***********************************************
  20 REM *                                             *
  30 REM * MULTI-COLOUR CHARACTER DEFINITION PROGRAM *
  40 REM *                                             *
  50 REM * AUTHOR :- B.J.W.ETHERINGTON                 *
  60 REM *                JANUARY 1983                 *
  70 REM *                                             *
  80 REM ***********************************************
  90 REM
 100 ON ERROR RUN
 110 DIM GRID%(8,8),ROW%(15,9),SHADE%(15)
 120 MODE 2
 130 PROC_INITIALISE
 140 PROC_INPUT:GOTO 140
 150 DATA RED,GREEN,YELLOW,BLUE,MAGENTA,CYAN,WHITE,FLASH BLACK-WHITE,FLASH RED-
CYAN,FLASH GREEN-MAGENTA,FLASH YELLOW-BLUE,FLASH BLUE-YELLOW,FLASH MAGENTA-GREEN
,FLASH CYAN-RED,FLASH WHITE-BLACK
 160 REM ************************************************** INITIALISE
 170 DEF PROC_INITIALISE
 180M%4,1
 190FOR I%=1 TO 8:FOR J%=1 TO 8:GRID%(I%,J%)=0:NEXT:NEXT
 200FORI%=1 TO 15:ROW%(I%,9)=0:RERD SHADE%(I%):NEXT
 210X%=1:Y%=1
 220 VDU 23,224,&FF,&FF,&FF,&FF,&FF,&FF,&FF
 230 VDU 23,240,3,1,1,1,1,1,1,3
 240 VDU 23,241,0,0,0,0,0,0,129,255
 250 VDU 23:242,255,129,0,0,0,0,0,0
 260 VDU 23,243,192,128,128,128,128,128,128,192
 270 VDU 23,244,16,16,16,16,84,56,16,0
 280PROC_SCREEN
 290PROC_CURSORON
 300PROC_MOVE(0,0)
 310PROC_DISPLAY
 320ENDPROC
 330REM ************************************************** SCREEN
 340DEF PROC_SCREEN
 350CLS:COLOUR 7
 360PRINT " CHARACTER DEFINER"
 370 COLOUR 2
 380 PRINT TAB(0,14)"Use normal cursor";
 390PRINT TAB(0,15)"movement keys to";
 400PRINT TAB(0,16)"position cursor.";
 410 PRINT TAB(0,18)"Make a mark using";
 420 PRINT TAB(0,19)"the COPY key.";
 430 PRINT TAB(0,21)"Erase a mark using";
 440 PRINT TAB(0,22)"the DELETE key.";
 450 PRINT TAB(0,24)"Press SPACE BRR to";
 460 PRINT TAB(0,25)"change ink colour.";
 470 PRINT TAB(0,27)"Press ESCAPE to";
 480 PRINT TAB(0,28)"define new character";
 490 FOR I%=1 TO 15:COLOUR I%:PRINT TAB(I%+1,31)CHR$(224);:NEXT
 500 INK%=6
 510 PROC_INK
 520PRINT TAB(6,1);STRING$(8,CHR$(241));
 530PRINT TAB(6,10);STRING$(8,CHR$(242));
 540 VDU 31,5,2,240,0,10,240,0,10,240,0,10,240,0,10,240,0,10,240,0,10,240,0,10-
240
 550 VDU 31,14,2,243,0,10,243,0,10,243,0,10,243,0,10,243,0,10,243,0,10,243,0,10
,243
 560 ENDPROC
 570REM ************************************************** INPUT
 580DEF PROC_INPUT
 590 A=GET
 600 IF A=&86 PROC_MOVE(-1,0):ENDPROC
 610 IF A=&89 PROC_MOVE(1,0):ENDPROC
 620 IF A=&88 PROC_MOVE(0,-1):ENDPROC
 630 IF A=&8A PROC_MOVE(0,1):ENDPROC
 640 IF A=&20 PROC_INK:ENDPROC
 650 IF A=&87 PROC_MARK(INK%):ENDPROC
 660 IF A=&7F PROC_MARK(0):ENDPROC
 670ENDPROC
 680REM ************************************************** MOVE
 690DEF PROC_MOVE(XINC%,YINC%)
 700X%=X%+XINC%:Y%=Y%+YINC%
 710IF X%>8 X%=1
 720IF X%<1 X%=8
 730IF Y%>8 Y%=1
 740IF Y%<1 Y%=8
 750 PRINT TAB(X%+5,Y%+1);
 760ENDPROC
 770REM ************************************************** MARK
 780DEF PROC_MARK(A%)
 790IF GRID%(Y%,X%)=A% ENDPROC
 800COLOUR A%
 810VDU 224,8
 820IF GRID%(Y%,X%)>0 TINK%=GRID%(Y%,X%):GRID%(Y%,X%)=0:PROC_CALC(TINK%)
 830GRID%(Y%,X%)=A%
 840 PROC_DISPLAY
 850ENDPROC
 860REM ************************************************** INK
 870DEF PROC_INK
 880PROC_CURSOROFF
 890COLOUR 7
 900PRINT TAB(INK%+1,30);" ";
 910INK%=INK%+1
 920IF INK%>15 INK%=1
 930PRINT TAB(INK%+1,30);CHR$(244);
 940PRINT TAB(0,11);STRING$(40," ");
 950 PRINT TAB(0,11);SHADE%(INK%);
 960COLOUR INK%
 970PROC_VDU
 980PROC_MOVE(0,0)
 990PROC_CURSORON
 1000ENDPROC
 1010REM ************************************************** DISPLAY
 1020DEF PROC_DISPLAY
 1030PROC_CURSOROFF
 1040PROC_VDU
 1050 VDU 5
 1060 MOVE 192,847
 1070 VDU 9,127
 1080FOR I%=1 TO 15
 1090IF ROW%(I%,9)=1 PROC_SHOW(I%)
 1100NEXT
 1110 VDU 4
 1120 COLOUR INK%
 1130PROC_MOVE(0,0)
 1140PROC_CURSORON
 1150ENDPROC
 1160 REM ************************************************** CURSOROFF
 1170 DEF PROC_CURSOROFF
 1180VDU 23,0,10,32,0,0,0
 1190 ENDPROC
 1200 REM ************************************************** CURSORON
 1210 DEF PROC_CURSORON
 1220VDU 23,0,10,67,0,0,0
 1230VDU 23,0,11,4,0,0,0
 1240ENDPROC
 1250 REM ************************************************** SHOW
 1260 DEF PROC_SHOW(A%)
 1270 COL.0,A%
 1280VDU 23,A%+224,ROW%(A%,1),ROW%(A%,2),ROW%(A%,3),ROW%(A%,4),ROW%(A%,5),ROW%(A
%,6),ROW%(A%,7),ROW%(A%,8)
 1290 MOVE 192,847
 1300 VDU A%+224
 1310 ENDPROC
 1320 REM ************************************************** CALC
 1330 DEF PROC_CALC(A%)
 1340ROW%(A%,9)=0
 1350FOR J%=1 TO 8
 1360ROW%(A%,I%)=0
 1370FOR J%=1 TO 8
 1380IF GRID%(I%,J%)=A% ROW%(A%,I%)=ROW%(A%,I%)+(2^(8-J%)):ROW%(A%,9)=1
 1390NEXT:NEXT
 1400ENDPROC
 1410 REM ************************************************** VDU
 1420DEF PROC_VDU
 1430PROC_CALC(INK%)
 1440COLOUR 7
 1450FOR I%=1 TO 8
 1460PRINT TAB(15,I%+1);"  ";
 1470PRINT TAB(15,I%+1)ROW%(INK%,I%);
 1480NEXT
 1490ENDPROC
```

Rally racer

D T C Breslin,
Byfleet,
Surrey.

ATOM

HERE IS A program for the Acorn Atom which tests a player's ability to steer down a twisting lane. Using a combination of Atom Basic and resident assembler, the program uses under 2K of memory, and also graphic mode 2a — colour — so the screen RAM and floating point ROM must be fitted. The road is shown in a 3-D image as white dots and every time

(continued on page 181)

```
10 IF ?#99<>0 W=0;?#99=0
20 GOS.s
30 @=0
40 DIM LL5
50 F.J=0TO20;LL(J)=-1;N.
60 P.$21;F.J=1TO2;P=#2800
```

(listing continued on page 181)

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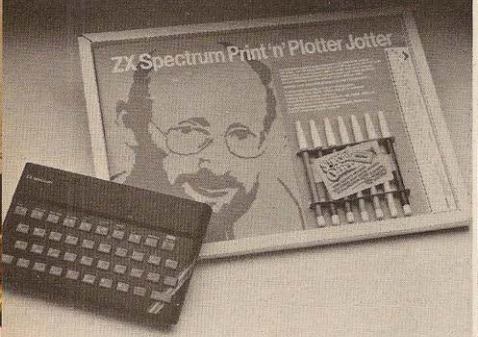

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Print 'n' Plotter Products

(listing continued from page 179)

```
70E
 80'LL0 JSR LL3:LDA #9A:CLC:ADC #9B:STA #9B:STA #3B1F:STA#3A1F
 90 JSR #FE7:LDA @0:STA #90
100 CPY @1:BNE LL1
110 LDA #9E:STA #90:CLC:ADC #9B:STA #9B
120'LL1 CPY @3:BNE LL2
130 LDA #9F:STA #90:CLC:ADC #9B:STA #9B
140'LL2 LDA #8002:EORA#4:STA#8002:RTS
150'LL3 LDX @0:STX #5B:STX #5D:STX #5E
160'LL4 STX #5C
170 LDA #3A00,X:STA #5A:CLC:ADC #90:SEC:SBC @1:STA #39FF,X
180 JSR LL5:LDX #5C:LDA #39FF,X:STA #5A:INC #5E
190 DEC #5C:JSR LL5:DEC #5E:INC #5C
200 LDX #5C:LDA #3800,X:STA #5A:SEC:ADC #90:STA #3AFF,X
210 JSR LL5:LDX #5C:LDA #3AFF,X:STA #5A:INC #5E
220 DEC #5C:JSR LL5:DEC #5E
230 LDX #5C:INX:INX:CPX @32:BNE LL4
240 LDA #87CE:ORA #87CF:ORA #87D0:ORA #87D1:STA #91:RTS
250'LL5 JMP(#3FE)
260J:N.:F.#6
270 C=0;L=0;B=#8002;H=2;K=1;?#9E=1;?#9F=254
280'CLEAR2:COLOUR1;?#5B=64:!#37EE=-1;GOS.d
290 F.J=0TO32;J!#3B00=32+J;J!#3B00=96-J;N.
300 L1.LL3:F.J=0TO180;WAIT;N.
```

(continued from page 179)

500 of these disappear off the bottom of the screen, the degree of difficulty increases until the player crashes three times. The score obtained and high score is printed and the game starts again.

Extra tools

Peter Barney,
Letchworth,
Hertfordshire.

SPECTRUM

USERS OF Bobby Rao's toolkit machine-code routines for the Spectrum — page 77, February, *Your Computer* — may find these routines useful also. List 3 and list 4 are high-resolution left and right scrolls, but in each case, the byte listed as 55 or 63 — use only one — will scroll with wrap around if 63, or with a white pixel from left or right, as appropriate, if 55. This same byte Poked 0 gives inverse characters with wrap around.

List 1 and list 2 are high-res up or down scrolls, which may be of interest as they are much shorter — 53 and 55 bytes — than the 99 and 97 of the published routines.

I have given the listings in decimal as I find these far easier to enter than hexadecimal. A suitable routine for entering the codes is given on page 180 of the manual.

```
 5 REM Demo Program
 10 CLEAR (PEEK 23675+256*PEEK 23676-200)
 60 GO SUB 120
 65 IF INKEY$="l" THEN POKE 32533,0: POKE 32563,0
 70 IF INKEY$="o" THEN RANDOMIZE USR 32400
 75 IF INKEY$="w" THEN POKE 32533,63: POKE 32563,63
 80 IF INKEY$="q" THEN RANDOMIZE USR 32460
 85 IF INKEY$="s" THEN GO SUB 120
 90 IF INKEY$="i" THEN RANDOMIZE USR 32520
 95 IF INKEY$="k" THEN POKE 32533,55: POKE 32563,55
100 IF INKEY$="r" THEN RANDOMIZE USR 32550
105 GO TO 65
110 GO TO 130
120 FOR i=0 TO 21: FOR j=0 TO 31: PRINT AT i,j;CHR$ (133+j): NEXT j: NEXT i
125 PRINT AT 10,5;"Type u for up          ";AT 11,5;"    d for down          ";AT
 12,5;"    r for right         ";AT 13,5;"    l for left          ";AT 14,5;"and
 s for start again ";AT 15,5;"    w for wrap around.";AT 16,5;"for inverse ";
CHR$ 34;"    ";CHR$ 34;"    ";AT 17,5;"    c cancels ";CHR$ 34;"    ";CHR$ 34;"
"
130 RETURN

LIST 4

32520  33   32521  255   32522  87   32523  6    32524  192
32525  197  32526  229   32527  221  32528  225  32529  221
32530  126  32531  225   32532  7    32533  55   32534  63
32535  6    32536  32    32537  203  32538  22   32539  43
32540  16   32541  251   32542  192  32543  16   32544  236
32545  201

LIST 3

32550  33   32551  0     32552  64   32553  6    32554  192
32555  197  32556  229   32557  221  32558  225  32559  221
32560  126  32561  31    32562  15   32563  55   32564  63
32565  6    32566  32    32567  203  32568  30   32569  35
32570  16   32571  251   32572  193  32573  16   32574  236
32575  201

LIST 2

32400  33   32401  31    32402  64   32403  84   32404  93
32405  37   32406  6     32407  3    32408  197  32409  6
32410  8    32411  197   32412  6    32413  8    32414  197
32415  36   32416  1     32417  32   32418  0    32419  237
32420  184  32421  17    32422  32   32423  0    32424  25
32425  84   32426  93    32427  193  32428  16   32429  240
32430  1    32431  32    32432  240  32433  9    32434  193
32435  16   32436  250   32437  62   32438  7    32439  132
32440  103  32441  193   32442  16   32443  220  32444  33
32445  225  32446  87    32447  6    32448  32   32449  35
32450  54   32451  0     32452  16   32453  251  32454  201

LIST 1

32460  33   32461  255   32462  87   32463  84   32464  93
32465  36   32466  6     32467  3    32468  197  32469  6
32470  8    32471  197   32472  6    32473  8    32474  197
32475  37   32476  1     32477  32   32478  0    32479  237
32480  184  32481  17    32482  32   32483  0    32484  25
32485  84   32486  93    32487  193  32488  16   32489  240
32490  1    32491  224   32492  7    32493  9    32494  193
32495  16   32496  250   32497  62   32498  249  32499  132
32500  103  32501  193   32502  16   32503  220  32504  37
32505  6    32506  32    32507  35   32508  54   32509  0
32510  16   32511  251   32512  201
```

The trap

Colin Hagreen,
Orpington,
Kent.

DRAGON

TRAP IS A game for two players, each player directing a line around the screen trying to force their opponent to hit one of the tracks formed or the boundaries of the court. Beware though as you can sometimes escape by cutting through a diagonal line. Be careful not to centre the joystick or you lose the game.

To start a game both players have to press the fire buttons. The overall winner is the first to score 10 wins. The lower-case letters in lines 350 and 360 are typed as inverse characters. PCopy is used to store the courts in another area of memory and lines 120 and 130 bring them on to the display faster than could be obtained by drawing them each time.

```
>   5 REM (C) C. HAGREEN '83
   10 PCLEARS
   20 PMODE1,3
   30 PCLS
   40 LINE(0,0)-(0,192),PSET:LINE-(255,192),PSET:LINE-(255,0),PS
ET:LINE-(0,0),PSET
   50 PMODE1,5
   60 PCLS
   70 PCOPY3 TO 5:PCOPY4 TO 6
   80 LINE(50,50)-(50,150),PSET:LINE(200,50)-(200,150),PSET
   90 A$=0:CS=0
  100 GOTO 280
  110 X=RND(2)
  120 PCOPY(X*2)*1 TO 1
  130 PCOPY(X*2)*2 TO 2
  140 PMODE1,1:SCREEN1,0
  150 X=120:Y=90:X1=100:Y1=90
  160 X=X+2*(JOYSTK(0)>51)-2*(JOYSTK(0)<12)
  170 Y=Y+2*(JOYSTK(1)>51)-2*(JOYSTK(1)<12)
  180 IF PPOINT(X,Y)<>1 THEN 270
  190 PSET(X,Y,2)
  200 X1=X1+2*(JOYSTK(2)>51)-2*(JOYSTK(2)<12)
  210 Y1=Y1+2*(JOYSTK(3)>51)-2*(JOYSTK(3)<12)
  220 IF PPOINT(X1,Y1)<>1 THEN 250
  230 PSET(X1,Y1,3)
  240 GOTO160
  250 CS=CS+1
  260 GOTO280
  270 A$=RS+1
  280 CLS:PRINT"                T R A P !":PRINT"                ---------"
  290 PRINT@128,"LEFT PLAYER                RIGHT PLAYER"
  300 PRINT@196,A$:PRINT@216,CS
  310 IF A$=10 OR CS=10 THEN 350
  320 PRINT" PRESS BOTH FIRE BUTTONS"
  330 IF PEEK(65280)<>124 AND PEEK(65280)<>252 THEN 330
  340 GOTO110
  350 IF A$=10 THEN PRINT:PRINT" left Player wins" ELSE PRINT:PR
INT" right Player wins"
  360 PRINT:PRINT:PRINT"  PRESS enter"
  370 A$=INKEY$:IF A$<>CHR$(13) THEN 370
  380 RUN
```

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COMPETITION CORNER

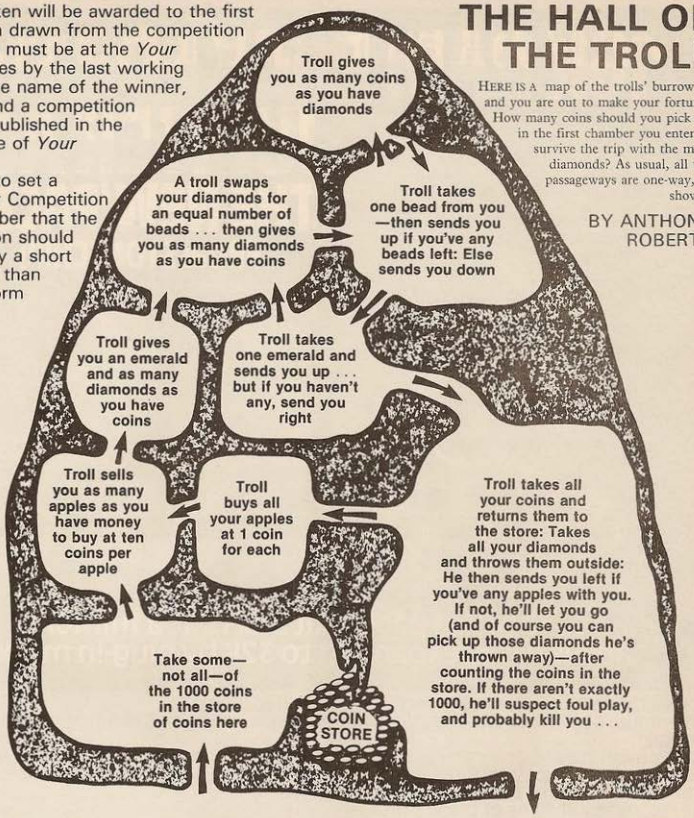
A £15 book token will be awarded to the first correct solution drawn from the competition bag. All entries must be at the *Your Computer* offices by the last working day in May. The name of the winner, the solution, and a competition report will be published in the July, 1983 issue of *Your Computer*.

If you want to set a competition for Competition Corner, remember that the simplest solution should be calculable by a short program rather than by any other form of reckoning.

THE HALL OF THE TROLL

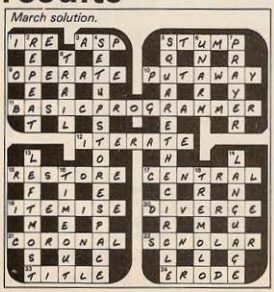
HERE IS A map of the trolls' burrow — and you are out to make your fortune. How many coins should you pick up in the first chamber you enter to survive the trip with the most diamonds? As usual, all the passageways are one-way, as shown.

BY ANTHONY ROBERTS



Competition results

March solution.



IN MARCH'S competition to win a Lynx computer competitors were asked to complete the sentence, "A Lynx would bring out the animal in me because . . .".

The prospect of winning a Lynx may not have brought out the animal in everyone but it certainly brought out the punsters, in force. "I could relion my feline instincts for purrfect programming", wrote G Bockhurst, while H Howarth suggested "It's the big-byte cat-grrreat grrraphics and a purrfect purrocessor to boot".

The winning entry came from the appropriately-named Dave Bull, 86 Milton Road, Southampton, Berkshire, who wrote "It's the purrfect way to be an on-line feline".

Some of the other puns were more obscure. We are still trying to puzzle out A Ridley's "If ewe bison, ewe kangaroo terrier-bull byte otter it".

More straightforward were M Glass's "It's ears ahead", and from A Patrick, "It provides the missing links to make me a cool Computer cat".

Mrs Allemand struck a suitably aggressive note, worthy of Marvel comics, with "as Catwoman I'd have power over those ZX-81 jokers". E Jupp's entry, however, took a more relaxed line and confided owlishly "I wynx and blynx, but the Lynx thynx".

Our problem setter slipped up with the Telepathic Dangers competition by setting a problem which had not one but two solutions. Two pairs of segments can be discarded from the cube of On'ey: C and E, and B and F. Many of the entries spotted the blunder and gave both correct solutions.

We awarded the £15 book token to P Hoskins, 30 Springfield Park, Holyport, Berkshire.

He enclosed a program for the Spectrum which not only worked out the solutions but plotted the diagrams of the two possible cubes.

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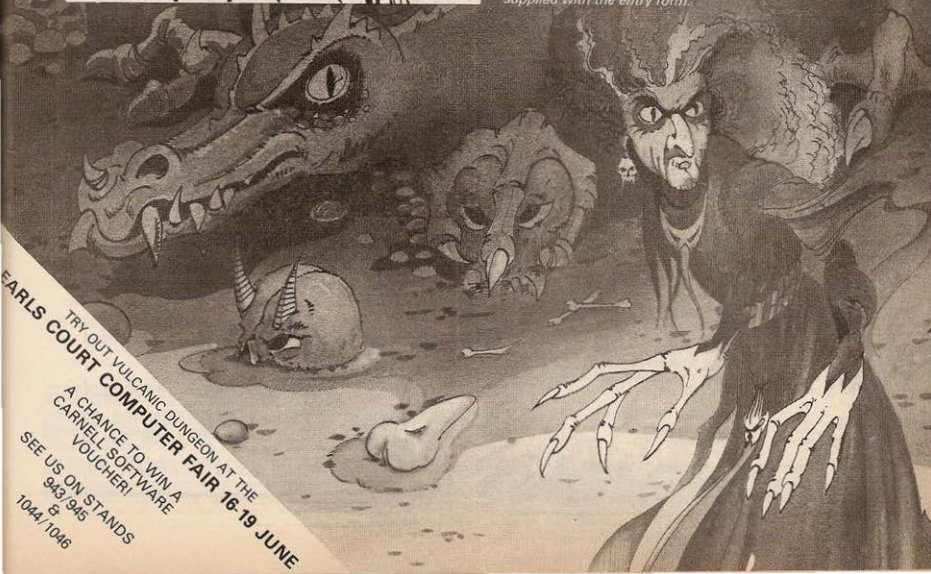

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Availability DRAGON 32: SPECTRUM 16K: ZX 81 16K

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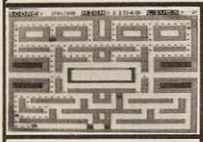

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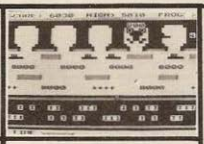

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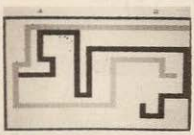

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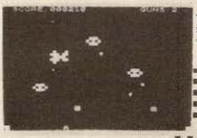

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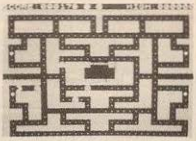

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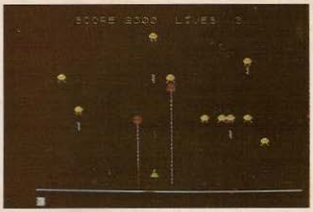

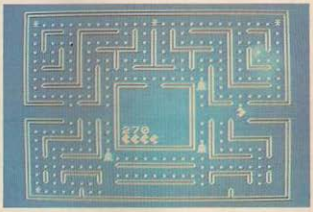

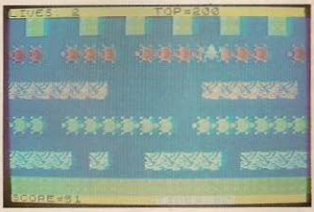

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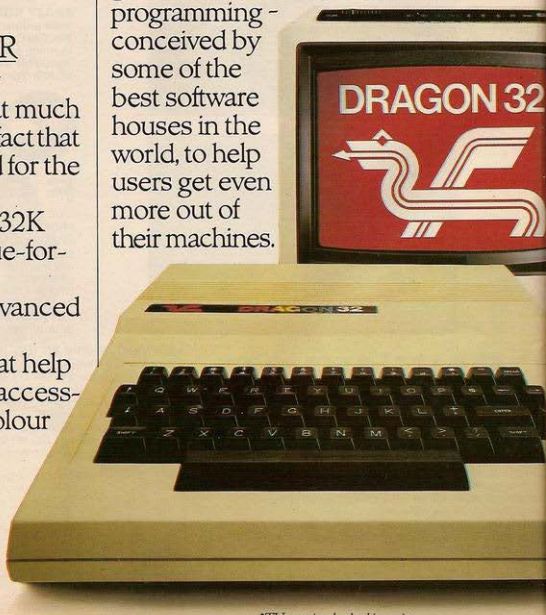

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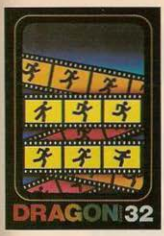

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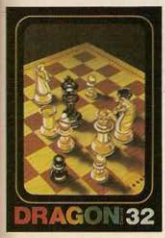

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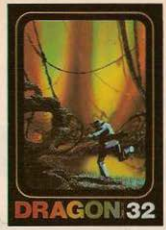

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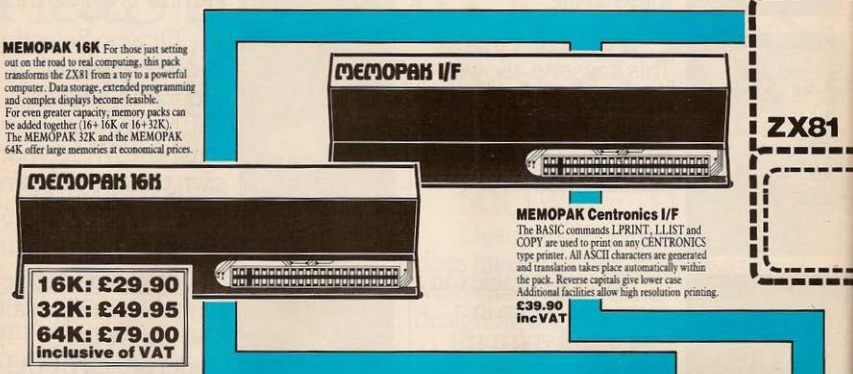

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It all adds up to an efficient, modular computer system

The **Memotech** approach to microcomputing is to take the well-proven and popular ZX81 as the heart of a modular system. This small computer houses the powerful Z80A processing unit and acts as the central processor module through which the **Memopaks** operate.

Memotech has a reputation for professional quality, producing units which are designed to fit perfectly, to look well-balanced, and to work efficiently and reliably.

The modular approach gives ZX81 owners the freedom to design the system they really need. Furthermore, the intercompatibility of the modules ensures that later additions will click straight in, to give you a system that grows with your ambitions and abilities.

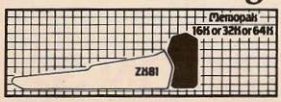
To ensure that your expectations are realised, care is taken at every stage to design features into the system to anticipate your needs. For example:
1) Memories are cumulative e.g. 16K and 32K can be added to the **Memopak 16K** or even to the Sinclair 16K RAM pack 2) The **HRG** firmware allows commonly used constructions (such as scrolling, shading and labelling graphs), to be called by a few simple commands. 3) The **Centronics I/F** converts ZX81 character codes into ASCII and extends the print line t the width of the printer, still using the LLIST, LPRINT and COPY commands.

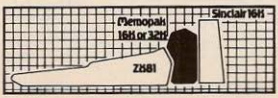
As one example, a system with 16K of memory and **Memocalc** is all that is required to perform the same sophisticated numerical projections as a computer at 10 times the price. The problem may be as complicated as a cash flow or production schedule, or as simple as household accounts o pocket money budgeting. If your bank manager wants to see cash flow, then a single print instruction to the **Centronics I** will give a printout which is more than acceptable.

The example system which is shown, on the other hand, would satisfy the needs of someone who wanted to enter data

How it all fits together

You can see from the diagrams how various Memotech/Sinclair units can be combined.

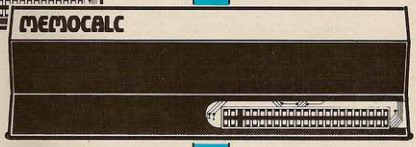




otech,
tial of your ZX81...

MEMOCALC The screen display behaves as a 'window' on a large sheet of paper on which a table of numbers is laid out. The maximum size of the table is determined by the memory capacity, and with a MEMOPAK 64K a table of up to 7000 numbers with up to 250 rows or 99 columns can be specified. Each location in the table can be either a number which is keyed in or a formula which generates a number.

£29.90 inc VAT



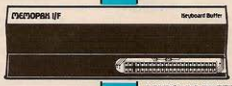
MEMOPAK HRG This pack breaks down the constraints imposed by operating at the ZX81 character level and allows high definition displays to be generated. All 248 x 192 individual pixels can be controlled using simple commands, and the built in software enables the user to work interactively at the dot, line, character, block and page levels. Scrolling, flashing and animation are all here.

£39.90 inc VAT

MEMOTECH KEYBOARD

The Memotech plug-in Keyboard plus buffer pack takes the effort out of data entry for ZX81 users. The Keyboard has a light professional touch and is housed in an elegant aluminium case. The simple plug-in system means that you are not obliged to open up your ZX81, use a soldering iron or invalidate your ZX81 warranty.

£49.95 inc VAT



KEYBOARD BUFFER PAK
The Buffer Pak performs a "housekeeping" function for the Keyboard, interfacing directly with the port at the back of your ZX81.

via a light-touch keyboard, construct and label graphs, and then copy the screen to an 80-column printer. Only 16K of memory is shown here but with additional memory, more than one video page can be stored. Up to 7 pages can be displayed in rapid succession to give animated displays.

Looking forward, **Memotech** will continue to back the ZX81 through 1983 with fast storage devices, pressure sensitive electronic drawing boards and more software packs including a **Wordprocessor,** an **RS232 Interface** and a **Z80 Assembler.**

MEMOTECH products are available from major branches of W.H. SMITH'S & JOHN MENZIES

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Kayde Standard Keyboard
This is used for both computers, but does not accomodate them inside the casing. Open your computer and plug in the connector. (The ZX81 requires two simple solder connections). The keyboard comes complete with high-impact black plastic case and full fitting instructions. The ZX81 has a repeat key.
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Kayde Super Plug-in Keyboard
This is the ultimate keyboard for your Sinclair computer, you simply plug it into the user port at the back. No disassembling. Complete with full-size space bar and ZX81 repeat key. **£49.95**

Kayde Deluxe Keyboard
This keyboard is also used for both types of computer but allows you to fit your computer inside. It also has a full size space bar and a ZX81 repeat key. The Spectrum version needs no soldering, the ZX81 two simple solder connections.
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All Kayde RAM Packs use state of the art technology and feature top-quality, low power memories. Housed in high-impact polysterene, they look good and are fully tested and guaranteed.

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Totally the same design as our 16K but giving you a massive 64K turning your machine into a very powerful computer **£59.95**

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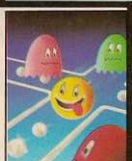

* Can only be used with 4K Graphics Board.

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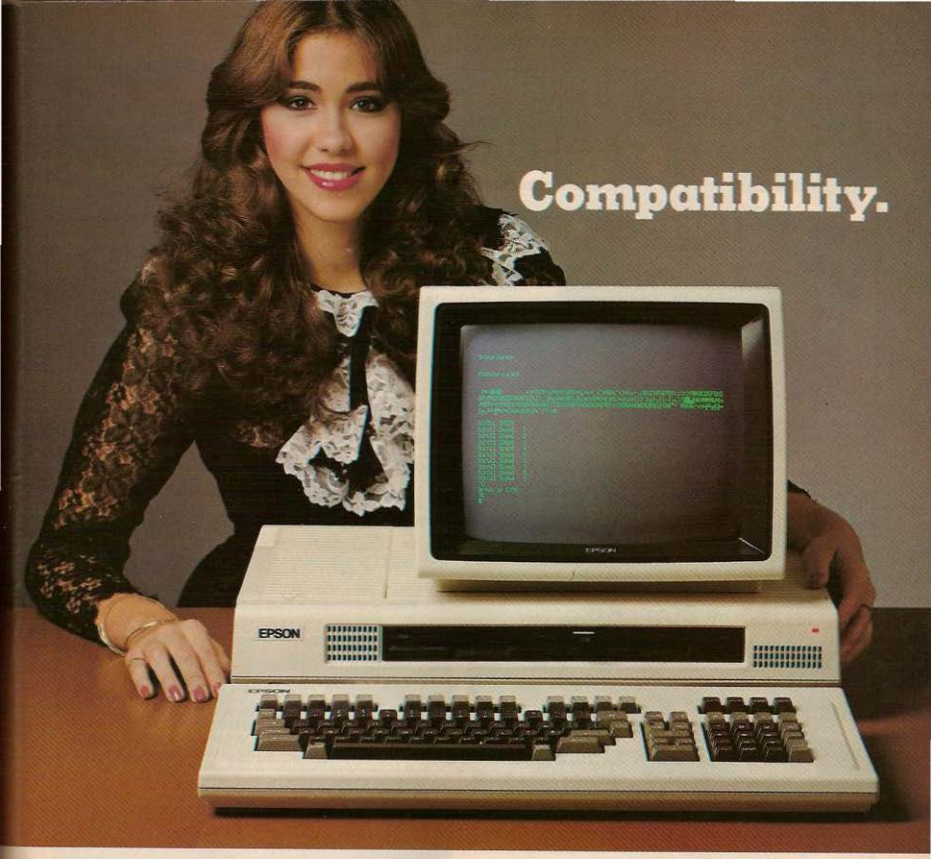

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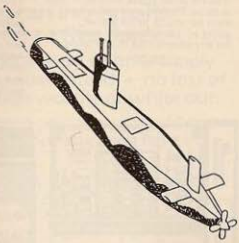
SOFTWARE



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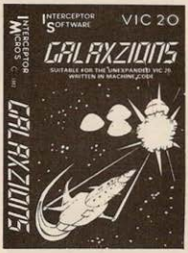

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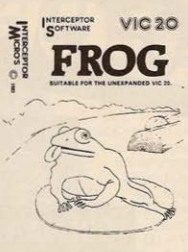

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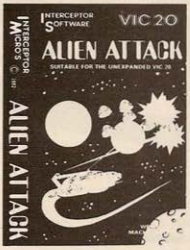

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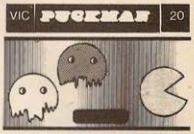

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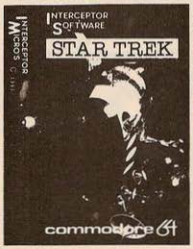

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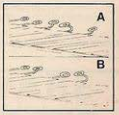

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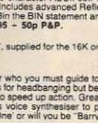

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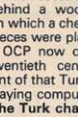

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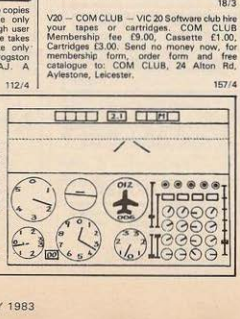

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A
A+F Software 106
Aardvark 166
Abacus 47
Acorn Computers 16/17
Acorn Peripheriess 170
ACS Software 110
Afdec 113, 186
Agf Hardware 141
Amba 193
Amersham Software 110
Anirog 104
Artic Computing 123
Audio Computers inside back cover
Auto Ram 113
Automata 69

B
Bamby Software 112
Beaumont Sumer Camp 192
Bee Bug 33
Bug Bear 191
Bipak 182
Bibi Magnetics 46
Bridge Software 139
Bugbyte 22/23

C
C P Software 26
C Tech 195, 208
Calpac 66
Campbell Systems 113
Canbridge Micro 84
Carnell Software 90, 185
Cascade Software 187
Century Publishing 109
Chromasonic Electronics 194
CJE Micro Computers 68
Commodore 96/97
Compro Sys 174
Computer Addons 205
Computer Rentals 163
Computers For All 4/5
Crystal Computing 37

D
DA Computers 86
Display Electronics 57
DJ1 Software 193
DK Tronics 12/13 144/145
Dobsoft 90
Doctor Soft 174
Downsway 52
Dragonndata 196/197
Durrel Systems 206

E
Ecce Production 139
Econotech 190
Elephant Software 69
Elfin Software 209
Eltec 138
Enterprises 33
Epson 201
Everyday Electronics 187

F
Fernleaf 60
Foilkade 190
Fox Electronics 209
Fuller Micro 202
Furlong Products 174

G
Gemini Marketing 92/93
Gemini Software 138
Gilsoft 192
Granada Publishing 98
Grundy 128/129

H
Hewson Consultants 36/37
Hi Soft 68
Hi Tech 166
H/H Software 142

I
Imagine Software back cover
Imagine Software 72/73/74/75/76/77
Impact Software 171
Interceptor Micros 204
Interface 166
IPC Exhibitions 10/11

J
J K Greye 80
J Morrison Micros 139
JRS Software 60
Jupiter Cantab 27

K
Kayde 200
Kemp Ltd 206
Kepston Micros 46, 150
Kuma 192

L
Laserbug 133
Leisure Mail 56
Level 9 68
Linsac 133
Llamsoft 221
Logical Education Software 90

M
Malva 80
Maplin Electronics 64, 117
MC Associates 190
Melbourne House 172
Melbourne House 136
Memotech 198/199
Micro Aids 143
Micro Deal 169
Micro Management 14/15
Micro Mana 69
Micro Mart 187
Micro Stak 130
Micro Ware Leicester 114
Micromart 160
Microstyle 61
Midwich 18
Micro Deal 41
Micro Game Simulations 40
Mikrogen 187
MST Consultants 188
Myrmidone 66

N
National ZX80 Club 82
Newnes Technology 66
Newstech 44
Northwish Inside front cover
Neptune Computer 130

O
Oakleaf 84
Oric Products 24/25
Oxford Computing Publishing 80

P
Phipps Associates 32
Picturesque/Addictive Games 46
Practical Electronics 182
Print + Plotter 180
Pro Software 139
Program Direct 203
Program Power 34
PSS 148/149
PV Micro Computer Centre 112

Q
Quark Data 112
Quicksilva 19, 20/21

R
RD Labs 207
Redditch Computers 86
Richard Shepperd 52

S
S W Winter 177
Salamander Software 154
Severn Software 85
Silica Shop 9
Silversoft 124/125
Sinclair Research 94/95
Sir Computers 86
Simon Software 84
Softex 146/147
Software Express 126/127
Software Farm 191
Spectrum Software 155/156/157/158
Stone Chip 8, 184
Sunshine Products 164
Superior Software 192
Swanley Electronics 60

T
Tangerine Computers 189
Tansoft 88
Tasman 151
The Dragon Dungeon 160
Timedata 186
Tomorrows World 207
Transform 138
Twickenham Computer Centre 40

U
UTS 110

V
V + H Computers Service 191
Vectis 208
Venn Software 182
Video Software 188
Vision Store 100, 130
Viking Software 160

W
W H Smith 6/7
William Stuart Systems 134
Wireless World 186
Workforce 40

Y
Yewacre 118

Z
Zxasa 56
Zygon Products 134

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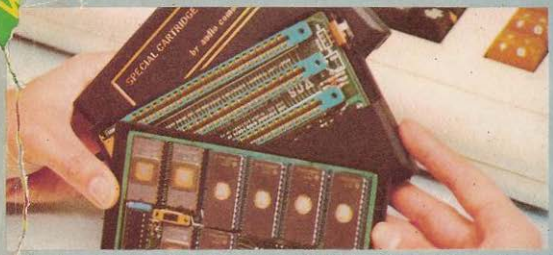

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Fig. 1

Fig. 2

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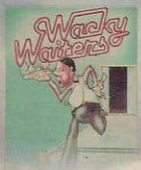

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